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EARLY ATTACHMENT STRESS, ATTENTIONAL CONTROL DYSFUNCTION
AND PROBLEMS WITH SELF-REGULATION

By

Joshua Bernstein, M.A. NCSP

Submitted in partial fulfillment of
the requirements for the degree
Doctor of Philosophy

School Psychology Doctoral Program
Department of Counseling, Psychology, and Special Education
School of Education
Duquesne University

May 2008

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Joshua D. Bernstein
2008

DUQUESNE UNIVERSITY
SCHOOL OF EDUCATION
Department of Counseling, Psychology and Special Education

Dissertation

Submitted in Partial Fulfillment of the Requirements
For the Degree of Doctor of Philosophy (Ph.D.)

School Psychology Doctoral Program

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EARLY ATTACHMENT STRESS, ATTENTIONAL CONTROL DYSFUNCTION
AND PROBLEMS WITH SELF-REGULATION

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ABSTRACT

EARLY ATTACHMENT STRESS, ATTENTIONAL CONTROL DYSFUNCTION AND PROBLEMS WITH SELF-REGULATION

By

Joshua D. Bernstein

January 2008

Dissertation Supervised by Jeffrey A. Miller, Ph.D., ABPP

Development of the self-regulatory elements of executive control is one of the most critical and significant developmental achievements of early childhood. Executive control and self-regulation are constructs that lie at the nexus of developmental, neuropsychological, and clinical investigations. *Effortful Control* (EC) is a construct representing a hybridization of these separate but intertwined notions. It describes the self regulatory aspects of the executive control system. The construct is of special interest and use, because, despite the traditional practice of conceptualizing cognitive and emotional processes independently of one another, the construct of EC places emotional, cognitive, and behavioral self-regulatory capacities

together. EC is meant to refer to emotional, social, and cognitive regulatory function, with the understanding that the separation of emotional, social, and cognitive developmental processes is an artifact of the fractionization of psychology, rather than an organically based distinction. The purpose of the study is to examine if securely attached children differ from children who manifest insecure attachment behavior in regard to their subsequent formation of EC processes after controlling for the effects of social contextual adversity.

DEDICATION

This study would not have been possible without the love, patience, and understanding of my family. This doctoral dissertation is dedicated to my wife, Shenoa, for standing by me through thick and thin, to my mother for her years of unconditional love and support, to my father for instilling in me a drive for excellence, and to my children, Orli Maia and Obadiah, for reminding me every day to work some, play some and love with all your heart.

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I owe a dept of gratitude to the entire faculty of Duquesne University's School Psychology Program for providing an excellent environment for learning, to the staff of Jewish Family and Children's Service for the trust and flexibility to both develop as a mental health professional and excel as a student, and to Jeffery Freedman Ph.D. my mentor and friend, thank you for believing in me. Finally, my thanks to the National Institute of Child Health and Human Development Study of Early Child Care for providing the longitudinal data utilized in this doctoral dissertation.

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CHAPTER I

INTRODUCTION

Development of the self-regulatory elements of executive control are arguably one of the most critical and significant developmental achievements of early childhood (Bandura, 1977; Kopp, 1982; Luria, 1980; Olson, Bates, & Bayles, 1990). Executive control and self-regulation are constructs that lie at the nexus of developmental, neuropsychological, and clinical investigations. Executive control and self-regulatory deficits each impact at least three major functional domains: (a) affective (NICHD Early Child Care Network, 2004), (b) cognitive (Luria, 1980; Olson et al., 1990), and (c) social (Denham, Blair, Shmidt, & DeMulder, 2002; Thompson, 1994). Because emotional, cognitive, and social processes are developmentally interrelated and interdependent (Bell & Wolfe, 2004; Davis, Bruce, & Gunnar, 2002; Iverson & Dunnnett, 1990; Lyons, Lopez, Yang, & Schatzberg, 2000; Posner & Rothbart, 2000) neither the terms *Executive Control* nor *Self-Regulation* adequately represent the myriad emotional, social and cognitive implications and bidirectional impacts of dysfunction in these arenas. The term *Executive Control* carries a connotation of neuropsychological and cognitive functioning, whereas *Self-Regulation* connotes social and emotional developmental processes.

Effortful Control (EC) is a construct representing a hybridization of these separate but intertwined notions (Posner & Rothbart, 2000; Rothbart, 1989; Rothbart & Bates, 1998; Rothbart, & Ahadi, 1994; Rothbart, Ahadi, & Hershey, 1994; Rothbart, Ellis, Rueda, & Posner, 2003). It describes the self regulatory aspects of the executive control system. The construct is of special interest and use, because, despite the traditional practice of conceptualizing cognitive and emotional processes as independent of one another, the

construct of EC places emotional, cognitive, and behavioral self-regulatory capacities together (Davis et al., 2002; Eisenberg & Spinrad, 2004; Posner & Rothbart, 2000). EC is meant to refer to emotional, social, and cognitive regulatory function, with the understanding that the separation of emotional, social, and cognitive developmental processes is an artifact of the fractionization of psychology, rather than an organically based distinction. Though EC is a construct developed by Rothbart and colleagues as part of their work on temperament (Posner & Rothbart, 2000; Rothbart, 1989; Rothbart, & Ahadi, 1994; Rothbart, Ahadi, & Hershey, 1994; Rothbart & Bates, 1998; Rothbart et al., 2003), the utility of conceptualizing emotional, social, and cognitive control processes together as a unitary notion that is salient to developmental outcomes beyond early childhood is unmistakable. Overwhelmingly, the evidence supports the interdependence between emotional, social, and cognitive functions (Bell & Wolfe, 2004; Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000). A consequence of serious dysfunction in any one of these domains (emotional, social, or cognitive) will most often result in decrements to self-regulatory and executive functioning (Cicchetti, 2002). For this reason the construct of EC is here extended upward to pertain to and describe emotional, social, and cognitive control processes through late childhood. This upward extension of Rothbart's and Bates' (1998) temperament construct will hopefully aid in the quest to develop a better understanding of psychopathology and the developmental pathogeneses of numerous disorders related to attention, executive function and conduct (Nigg, Goldsmith, & Sachek, 2004).

Dysregulated and undercontrolled children manifest difficulties controlling the intensity, valence, and duration of their affective experience (Powell & Kytja, 2004). Linehan (1993) identified three distinctive characteristics of emotional dysregulation including: a lower than typical affective arousal threshold, dramatic and intense emotional reactions, and a slower than typical return to affective baseline. These children often demonstrate more frequent and intense negative emotional states than do their better regulated peers. Cognitively, children experiencing poorly developed executive control show greater difficulty with “goal-oriented behavior in response to environmental contingencies” (Romine & Reynolds, 2005, p. 191) as well as problems with attentional focusing, planning, mental flexibility, (Eisenberg & Spinrad, 2004; Posner, 1995; Posner & Rothbart, 1998; Rothbart, Ahadi, & Hershey, 1994; Rothbart & Bates, 1998) memory, “internalized” speech, problem-solving (Luria, 1961; Mischel & Patterson, 1979; Wertsch, 1984 as cited by Olson et al., 1990), and, most critically, inhibitory/activational control (Stuss & Alexander, 2000) and response inhibition/impulse control problems (Barkley, 1997a). These emotional and cognitive difficulties are thought to contribute to poorly regulated children’s social and academic struggles (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001).

The Purpose

The purpose of the study is to examine if securely attached children differ from children who manifest insecure maternal attachment behavior in regard to their subsequent formation of EC processes related to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity.

Significance of the Problem

Children who manifest underdeveloped Effortful Control are poorly regulated children. These children evidence greater instances of internalizing and externalizing disorders than do their better regulated peers (Barkley, 1997a; Denham et al., 2002; Linehan, 1993; Loeber, Lahey, & Thomas, 1991; Lober & Stouthamer-Lober, 1998; Powell & Kytja, 2004). Additionally, the inhibition and impulse control deficits (impulsivity) associated with executive control dysfunction and poor self-regulation (low effortful control) are primary characteristics of many societal problems such as criminality (Levine & Jackson 2004), aggression (Dadds, Fraser, Frost, & Hawes, 2005), and addiction (Schmidt, Fallon, & Coccaro, 2004; Vigil-Colet & Codorniu-Raga, 2004). Inhibitory dysfunction is also a core deficit of externalizing disorders and of many mental and personality disorders including: attention-deficit/hyperactivity disorder (ADHD) (Barkley, 1997a), Conduct Disorder (Denham et al., 2002; Loeber, Lahey, & Thomas, 1991; Lober & Stouthamer-Lober, 1998), Obsessive-Compulsive Disorder (Avila, Cuenca, Félix, Parcet, & Miranda, 2004; Tamm, Menon & Reiss, 2002), and Borderline Personality Disorder (Linehan, 1993).

Impulsivity and the behaviors associated with an externalizing disorder and low EC capacity are particularly troubling in a classroom environment. These behaviors not only interfere with the afflicted student's learning, but the disruption created by the impulsive student will often detract from other students' educational experience.

Problems with EC clearly represent a major impediment to children in their attempt to successfully navigate the human developmental process. As such, it is incumbent upon psychological researchers to develop a thorough understanding of the etiological contributions to EC deficits.

Attachment Theory

Since John Bowlby (1969) began his work in 1956 investigating how young children cope with the “temporary loss of mother” (Bowlby, 1969, p. xi) the relationship between parents and their young children has been a major area of interest and debate. Attachment theorists and researchers have endeavored, for nearly fifty years, to provide empirical and theoretical support for the notion that children’s bond to their parental figure(s) is critical to normal human development.

Attachment theorists assert attachment is a primary biological process critical to adequate development of emotional, social and cognitive functioning (Ainsworth 1989; Beretheron, 1992; Bowlby, 1988; Brazelton & Greenspan, 2000; Karen, 1998; Sroufe, Carlson, Levy, & Egeland, 1999). Bowlby (1969, 1988) and Ainsworth (1989) define attachment as an important and lasting emotional bond between two people. This bond is specifically crucial between parents and their children. The attachment bond refers to the dimension of the parent/child relationship involving protection and security (i.e. regulation of environmental threats and stresses). Mary Ainsworth and her colleagues (Ainsworth, Blehar, Waters, & Wall, 1978) published a seminal work in which they advanced a nomenclature to describe “attachment patterns.” Ainsworth’s (1978) attachment nomenclature is characterized by (1) quality and (2) security of the

parent/child relationship. The quality of the young child's attachment bond to a care-provider is often discussed in terms of the security of the bond (e.g., secure, insecure).

A growing body of research supports the principal theoretical tenets of attachment theory: children's bond to their parental figure(s) is critical to normal human development, formation of a sense of self, and emotional regulation (Ainsworth 1989; Bowlby, 1988; Beretherton, 1992; Denham et al., 2002; Diener & Mangelsdorf, 2000). Children benefiting from strong and secure attachment relationships have demonstrated better outcomes than their less fortunate insecurely attached counterparts; for example, greater persistence and problem-solving skills, heightened levels of positive affect and enthusiasm (Matas, Arend, & Sroufe, 1978), and superior attention span (Maslin-Cole & Spieker, 1990) have been demonstrated. Additionally, secure attachment relationships have been shown to mediate the negative impacts of low social economic status and other social contextual risk factors (Pasco-Fearon & Belsky, 2004).

Disrupted and insecure attachment relationships can impact the formation of critical neurological control systems leading to deleterious emotional, behavioral, and cognitive outcomes such as increased rates of internalizing and externalizing disorders (Fabes et al., 1999; Gross & John, 2003; Kopp, 1989), underdeveloped social competence (Denham et al., 2002; Thompson, 1994), and increased rates of psychopathology including oppositional defiant disorder and conduct disorder (Denham et al., 2002; Thompson, 1994), anxiety and depression (Gerhardt, 2004), and ADHD (Barkley, 1997a; Clarke, Ungerer, Chahoud, Johnson, & Stiefel, 2002).

Attachment and Developmental Processes

Primary attachment relationships impact subsequent human developmental processes and outcomes (Ainsworth 1989; Bowlby, 1988; Beretheron, 1992; Clarke et al., 2002; Denham et al., 2002; Diener & Mangelsdorf, 2000; Fabes et al., 1999; Gross & John, 2003; Kopp, 1989). Abundant evidence exists supporting this most central tenet of attachment theory (Cicchetti, 2002). That is, the quality of a child's primary attachment relationship has been found to be positively correlated to the quality of emotional (Ainsworth 1989; Bowlby, 1988; Beretheron, 1992; Denham et al., 2002; Diener & Mangelsdorf, 2000, Gerhardt, 2004), social (Granot, & Mayseless, 2001; Lefreniere, 2000; Sroufe, 1996), cognitive (Gunnar, Broaderson, Nachmias, Buss, & Rigatuso, 1996; Nachmias, Gunnar, Mangelsdorf, Hornik-Parritz, & Buss, 1996) and neurobiological (Schoore, 2001A, 2001B, 2001C) developmental outcomes. The attachment relationship is, in essence, an early and powerful social emotional developmental *experience* (Ainsworth 1989; Beretheron, 1992; Bowlby, 1988; Sroufe et al., 1999); an experience that has been established as contributing to personality and social emotional development (Lefreniere, 2000; Sroufe, 1996; Sroufe et al., 1999).

Attachment and the Growing Brain

A diversity of psychological literatures offer support and evidence for the notion that disrupted and insecure attachment relationships can contribute to a myriad of negative developmental outcomes (Sroufe et al., 1999). Neurodevelopmental researchers have been working to demonstrate that the complex and dynamic interaction between our genetic predisposition and our experiences significantly informs the development of neural architecture and neuropsychological function (Cicchetti, 2002; Cicchetti &

Tucker, 1994; Eisenberg, 1995; Gerhardt, 2004). Developmental psychological and neuropsychological literature support the notion, advanced by attachment theorists (Bowlby, 1969) that emotional, social, cognitive, and neurobiological developmental processes are interrelated and interdependent upon one another (Bell & Wolfe, 2004; Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000). These co-developing systems are inextricably and anatomically bound in the frontal cortex and in the anterior cingulate cortex (Bell & Wolfe, 2004; Davis et al., 2002; Posner & Rothbart, 2000). These competencies concurrently mature and recursively depend upon each other for optimal function (Cicchetti, 2002; Cicchetti & Tucker, 1994). Recent research into the anterior cingulate cortex reveals its dual function as a regulator of cognition and emotion (Bell & Wolfe, 2004). A critical implication of these findings is that the development of EC and self-regulation capacities is an integrative process incorporating emotional, social, and cognitive developmental processes. Disruption of experiences critical to emotional, social, or neurobiological development will lead to a cascade of developmental consequences (Cicchetti, 2002; Matas et al., 1978; Sroufe et al., 1999) likely including a diminished ability to exercise optimal EC capacities. This hypothesized impact of relational trauma upon the subsequent formation of higher order abilities described by the construct of EC is perhaps the most damaging and pervasive developmental consequence yet to be considered as a possible result of an insecure primary attachment relationship.

Executive Function, Executive Control, & Effortful Control

Executive function is an umbrella concept used to describe “higher order” cognitive skills and abilities required for controlling and coordinating performance in the face of

social, emotional and cognitively complex, demanding, and novel tasks (Alexander & Stuss, 2000; Andrews, 2001; Baddeley, 1997a; Barkley, 1997b; Baron, 2004; Klenberg, Korkam, & Lahti-Nuuttila, 2001; Leon-Carrion, Garcia-Orza, & Perez-Santamaria, 2004; Shachar & Logan, 1990; Lezak, 1995; Norman & Shallice, 1986; Wu, Anderson, & Castiello, 2002). Executive control functions are core “executive functions” (Alexander & Stuss, 2000; Stuss & Alexander, 2000) simply because the control systems facilitate the differential activation and deactivation of a range of “higher order” cognitive and emotional functions (Davis et al., 2002; Miller, 2005; Posner, 1995; Posner & Rothbart, 1998) including: attentional focusing, self monitoring, cueing the initiation of effort, inhibitory and activational control, response inhibition, planning, mental flexibility, working memory, and self-regulation (Alexander & Stuss, 2000; Andrews, 2001; Baron, 2004; Davis et al., 2002; Eisenberg & Spinrad, 2004; Lezak, 1995; Rothbart et al., 1994; Posner, 1995; Posner & Rothbart, 1998; Rothbart & Bates, 1998).

Stuss and Alexander (2000) emphasize a critical point regarding the conceptualization of executive control function(s), namely “there is no frontal homunculus, no unitary executive function” (p. 291). By positing that no single master control center exists, Stuss and Alexander are not suggesting that no control system exists, only that the system is comprised of multiple independently functioning “regulators.” Each regulator governs a distinct function while working in concordance with the other regulators to maintain organized, goal-directed, and self-regulated behavior (Alexander & Stuss, 2000; Stuss & Alexander, 2000).

Effortful Control is a construct describing aspects of the executive control system. As stated earlier, the construct of EC is uniquely useful because it combines emotional,

cognitive, and behavioral self-regulatory capacities (Davis et al., 2002; Eisenberg & Spinrad, 2004; Posner & Rothbart, 2000). Though EC is a construct developed by Rothbart and colleagues as part of their work on temperament (Posner & Rothbart, 2000; Rothbart, 1989; Rothbart et al., 1994; Rothbart et al., 2003; Rothbart, & Ahadi, 1994; Rothbart & Bates, 1998), the utility of conceptualizing emotional, social, and cognitive control processes together as a unitary notion that is salient to developmental outcomes beyond early childhood is unmistakable. Because an abundance of evidence supports the notion of an interdependence and reciprocal interaction between emotional, social, and cognitive functions (Bell & Wolfe, 2004; Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000). A consequence of underdeveloped functional capacity in any one of these domains (emotional, social, or cognitive) will most often result in decrements to self-regulatory and executive functioning (Cicchetti, 2002). For this reason the construct of EC is here extended upward to pertain to and describe emotional, social, and cognitive control processes through early adolescence. This upward extension of Rothbart and Bates (1998) temperament construct will hopefully aid in the quest to develop a better understanding of psychopathology and the developmental pathogeneses of numerous disorders related to attention, executive function, self regulation and conduct (Nigg et al., 2004).

Optimal EC function is associated with effective self-regulation, emotional-regulation, adaptability, flexibility, inhibition of response (impulse control), and attentional control (Davis et al., 2002; Murray & Kochanska, 2002; Posner, 1995; Posner & Rothbart, 1998; Rothbart & Bates, 1998). Conversely, diminished EC functioning is

associated with poor or ineffective self-regulation, inattention, impulsivity, diminished mental control, hyperactivity, aggression, disorganization, and emotional lability.

Though the construct of EC has several definitions, a consensus exists that the construct of EC pertains to the differential activation and deactivation of a range of cognitive and emotional executive control functions (Davis et al., 2002; Murray & Kochanska, 2002; Posner, 1995; Posner & Rothbart, 1998) including: attentional focusing and control, inhibitory and activational control, response inhibition, planning, mental flexibility, affect regulation, and self-regulation (Davis et al., 2002; Eisenberg & Spinrad, 2004; Rothbart et al., 1994; Rothbart & Bates, 1998; Posner, 1995; Posner & Rothbart, 1998).

Sex and Effortful Control

A definitive accumulation of evidence exists, indicating boys and girls differ in regard to their capacity to exercise effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation (Else-Quest, Hyde, Goldsmith, & Van-Hulle, 2006). Girls consistently outperform boys on attentional measures and measures of behavioral control (Carlson, Tamm, & Gaub, 1997; Else-Quest et al., 2006; Pasco-Fearon & Belsky, 2004; Gaub & Carlson, 1997; Johnson et al., 1999; Kochanska & Knaack, 2003; Levy, Hay, Bennett, McStephen, 2005). The preponderance of this evidence has been accumulated under the auspices of ADHD research and investigations of ADHD comorbidity. Clinic referred boys are more likely to meet ADHD diagnostic criteria than clinic referred girls (Johnson et al., 1999). Girls with ADHD are more likely to exhibit comorbid internalizing disorders (often anxiety) (Levy et al., 2005) and social impairment (Carlson et al., 1997), whereas boys with ADHD more often manifest

externalizing disorders. These boys diagnosed with ADHD are consistently perceived as more aggressive, hyperactive, and oppositional and defiant than their female counterparts (Johnson et al., 1999; Levy et al., 2005). Research examining sex differences among non-referred children's attentional and effortfully controlled behavior reveals a similar result. Girls consistently, across studies, outperform boys at attentional and EC tasks (Else-Quest et al., 2006; Kochanska & Knaack, 2003; Pasco-Fearon & Belsky, 2004; Rothbart et al., 2003).

The above cited research provides ample reason to believe girls manifest significantly different developmental trajectories in regard to the formation of effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation than boys. It is therefore reasonable to study boys' and girls' capacity to exercise effortfully controlled behavior independently from one another.

Environmental and Psychosocial Contributions to the Pathogenesis of Poor Effortful Control

The preponderance of evidence supports the notion of a strong positive relationship between high levels of social contextual stress (Belsky & Pasco-Fearon, 2002; Biederman et al., 1995; NICHD Early Child Care Research Network, 2003; Rutter & Sroufe, 2000) and decrements in the area of EC related to attentional control, impulsivity, and emotional regulation. It will here be argued a rationale exists to support an investigation of the effects of insecure attachment to a primary care provider while controlling for the effects of social contextual adversity.

The critical role of the child's early environment and psychosocial context upon subsequent developmental outcomes is widely accepted (Bowlby, 1969; Bronfenbrenner,

1979; Cicchetti, 2002; Rutter & Quinton, 1977; Rutter & Sroufe, 2000; Vygotsky, 1978). A strong and growing literature supports the contention that children's ability to exercise effortfully controlled behavior including children's attentional capacity is negatively impacted by adverse environmental and psychosocial circumstances (Clarke et al., 2002; Fabes et al., 1999; Fox, 1994a; Gross & John, 2003; Kopp, 1989; Landry et al., 2000; Landry et al., 2002). Several recent publications by the NIHCD Early Child Care Research Network (2003, 2005a, 2005b) have demonstrated associations between children's school readiness, ability to sustain attention and control impulsive urges with a variety of indicators of social adversity, including familial environmental factors, socioeconomic status, and the sensitivity of their care providers. A vast literature exists linking poverty (Bradley & Corwyn, 2002; Costello, Compton, Keeler, & Angold, 2003), harsh or coercive parenting (Gartstein & Fagot, 2003; Lecuyer-Maus, & Houck, 2002; Morrell & Murray, 2003), maternal mental illness (Biederman et al., 1995), and child abuse, neglect and maltreatment (Cicchetti, 2004; Higgins & McCabe, 2003) to externalizing disorders and symptoms consistent with the diagnosis of ADHD.

Rutter and Quinton (1977) assert and provide compelling evidence that the aggregate of multiple social contextual adversity factors better predict mental illness and negative outcomes rather than any single psychosocial contextual risk factor. They studied children raised on the Isle of Wight (a rural sample) and children growing up in the urban social context of London, England. Rutter's team identified six social contextual risk factors that were associated with behavioral and emotional disturbance regardless of their broader environmental context: 1) low socioeconomic status, 2) marital disruption, 3)

large family, 4) paternal criminal involvement, 5) maternal mental illness, and 6) out-of-home placement.

More recent research has produced findings consistent with Rutter and Quinton's classic work (1977). Gartstein and Fagot's (2003) hierarchical regression models showed a negative correlation between children's EC at age five and parental self-endorsement of a number of psychosocial contextual risk factors concerning the nuclear family unit including depressive symptoms, and observations of marital turmoil and coercive/harsh parenting practices. Barkley's (1997a) position is consistent with the work of Rutter and Quinton (1977), as is the work of Beiderman et al., (1995) Liaw and Brooks-Gunn (1994), Sameroff, Seifer, Baldwin, and Baldwin (1993) and Rutter and Sroufe (2000). These authors' findings are supportive of the general conclusion it is the aggregate of multiple social contextual adversity factors in the environment that impact developmental outcomes of children suffering from EC dysfunction, rather than any single adversity factor (Rutter, 2000; Rutter & Sroufe, 2000; Sameroff, 2000).

The strength and abundance of the above cited research provides ample reason to investigate the effects of the attachment relationship in isolation from the potentially confounding consequences of other social contextual adversity factors proven to be deleterious to children's developing neuropsychological and psychosocial functioning.

Attachment and Effortful Control

It will be argued that that a rationale exists to support the view that insecure attachment to a primary care provider can impact developing neuropsychological (Essex, Klein, Cho, & Kalin, 2002; Gerhardt, 2004; Lyons, Yang, Mobley, Nickerson, & Schatzberg, 2000; Schore, 2001a; Schore, 2001b; Schore, 2001c) and psychosocial

functioning (Ainsworth 1989; Berethernton, 1992; Bowlby, 1988; Brazelton & Greenspan, 2000; Karen, 1998) in such a way as to *cause* significant disruption of EC processes related to attentional control, impulsivity, and emotional regulation. The latest neural developmental research posits neural architecture and neuropsychological function are shaped as a consequence of the dynamic and recursive interplay between social experience and genetic predisposition (Cicchetti, 2002; Cicchetti & Tucker, 1994; Eisenberg, 1995; Gerhardt, 2004). The implication of this growing body of evidence is that biology not only shapes psychological, social, and emotional processes, but that social, emotional, and psychological experiences in turn, actively shape biology, modify gene expression, and impact the brain's structure and function (Cicchetti, 2002; Cicchetti & Tucker, 1994; Eisenberg, 1995; Kandel, 1998; Schore, 2001a). In light of this sort of reciprocal developmental process, the potential consequences of social, emotional, and psychological disruption(s), such as precipitated by an insecure primary attachment relationship, are staggering. Highly stressful, abusive, or disruptive early relationships can impede cognitive, social, and emotional development, leading to mental illness, adjustment and achievement difficulties, and sub-optimal cognitive outcomes (Denham et al., 2002; Fabes et al., 1999; Gerhardt, 2004; Gross & John, 2003; Kopp, 1989; Thompson, 1994).

Evidence exists indicating disruptions in the early attachment relationship can impact the developmental course of critical neural structures and systems (Essex et al., 2002; Gerhardt, 2004; Lyons et al., 2000; Schore, 2001a; Schore, 2001b; Schore, 2001c). Disruptive social, emotional, or psychological experiences can amass deleterious impacts upon the brain's executive control centers and disturb EC functions related to attentional

control, impulsivity, and emotional regulation across childhood (Lyons et al., 2000; Schore, 2001c).

Executive control functions described by the construct of EC are highly susceptible to the effects of negative social experiences, such as precipitated by an insecure primary attachment (Lyons et al., 2000; Schore, 2001c). This effect transpires because the development of EC capacities depends upon emotional, social, and cognitive processes to develop in tandem with neurobiological systems (Cicchetti, 2002; Cicchetti & Tucker, 1994; Eisenberg, 1995; Kopp, 1982). The successful development and function of these neurobiological, emotional, cognitive, and behavioral self-regulatory capacities are inter-dependant, each sharing functional aspects with the other (Cicchetti, 2002; Cicchetti & Tucker, 1994; Eisenberg, 1995; Kopp, 1982). Without ample remediation and protective factors, disruption in any single domain will likely lead to a compounding of difficulties across domains (Cicchetti, 2002). The consequences of such disruptions can be dire. Children who have poorly developed EC capacities often suffer emotional (Blair, Denham, Kachanoff & Whipple, 2004; Thompson, 1994) social, (Thompson, 1994), and cognitive (Brazelton & Greenspan, 2000; Murray & Kochanska, 2002; Schore, 2001; Gerhardt, 2004) consequences.

Importance of the Maternal Attachment Relationship

An examination of the association between disrupted attachment and the eventual development of EC function is necessary because research is, as yet, unable to conclusively establish a definitive set of factors or chain of events that lead to the formation of executive control dysfunction and self-regulation problems (Barkley, 1997a; Biederman et al., 1992; Clarke et al., 2002). This lacuna in the literature base results in

several problems including: etiological disagreement concerning the relative importance of the contribution of social experience to the formation of executive control dysfunction symptoms related to attentional control, impulsivity, and emotional regulation (Barkley, 1997b; Biederman et al., 1992; Pennington & Ozonoff, 1996), disagreement regarding intervention and treatment efforts (Clarke et al., 2002), and problems with the theoretical models guiding many developmental and neuropsychological studies.

Etiological Uncertainty

Despite the above mentioned etiological uncertainty of self-regulation problems, most current research efforts have predominantly focused on biological/genetic causative pathways (Barkley, 1997b; Biederman et al., 1992; Pennington & Ozonoff, 1996). This concentration of research efforts attempting to understand and explain the biological/genetic causative pathways to the formation of executive control dysfunction and self-regulation problems does not consider research directed toward exploring social/environmental/contextual factors' (i.e. parenting, peers, school, community) contribution to the pathogenesis of executive control dysfunction. Rather than understanding social/environmental/contextual stress as contributing to primary causation of executive control dysregulation, the popular position articulated in the literature casts the effects of social/environmental/contextual stress as mediators of the severity of executive control dysfunction and self-regulation problems (Barkley, 1997b; Biederman et al., 1992; Biederman et al., 1995). For example, Barkley (1997a) reports that the accumulated evidence generated by twin studies (Faraone, & Biederman, 1994; Levy, Hay, McStephen, Wood, & Waldman, 1997) suggest social environmental factors contribute only marginal variance to *primary causation* of executive control dysfunction. Barkley's

position is somewhat inline with the work of Rutter and Quinton (1977) as well as Beiderman et al., (1995) who assert it is the aggregate of multiple social contextual adversity factors in the environment that impact developmental outcomes of children suffering from executive control dysfunction, rather than either any unitary adversity factor or that these combined factors *cause* executive control dysfunction and problems with self-regulation. Barkley (1997), like Rutter and Quinton (1977) and Beiderman et al., (1995) concedes that environmental considerations can significantly impact children's outcomes, specifically, outcomes related to the formation of comorbid conditions such as: oppositional defiant disorder, conduct disorder, anxiety, and depression (Barkley, 1997b).

An alternative and contrasting etiological position holds that neurobiological and psychosocial developmental processes, antecedent to children's self-regulation and control capacities are reliant upon early relational experiences with primary care providers (Beretherton, 1992; Bowlby, 1988; Brazelton & Greenspan, 2000; Essex et al., 2002; Gerhardt, 2004; Kopp, 1982; Lyons et al., 2000; Schore, 2001a; Schore, 2001b; Schore, 2001c; Sroufe, 1996; Tronick, 1989). By demonstrating the effect of attachment security upon the subsequent development of EC, progress towards the goal of establishing a definitive set of factors that contribute to the formation of executive control dysfunction and self-regulation problems will be made.

Intervention and Treatment

From the perspective of proponents advancing a biological/genetic etiological account of developmental executive control dysfunction psychosocial prevention and treatment efforts are of limited utility for remediation of neuropsychological deficits. This position is logical and consistent with the principal implications of a biological/genetic

explanation of self-regulation difficulties. Psychosocial prevention and intervention efforts from this point of view are insufficient to counter what is at its core, a neurobiological deficiency. Psychosocial prevention and intervention efforts are recognized as an effective supplement to psychopharmacological treatment efforts, but effective only to counter and prevent the advent of associated comorbid conditions (i.e., oppositional defiant disorder, conduct disorder, anxiety, and depression) (Barkley, 1997b).

Alternatively, developmental psychologists who advance a social/environmental /contextual etiological account of developmental executive control dysfunction argue psychosocial stress can contribute to primary causation of executive control dysregulation (Rothbaum, & Weisz, 1994). These theorists hold that relational transactions between parent-child dyads and triads are an optimal arena for prevention and treatment interventions (Sanders, 1996, 1999). Researchers have identified parenting practices effective for fostering children's competence in regulating and controlling themselves, and have determined what parent training and psychosocial interventions are effective (LeCuyer-Maus & Houck, 2002; Sanders, 1996, 1999). Understanding effective intervention strategies directed toward strengthening children's self control/regulation systems is critical to symptom resolution.

Theoretical Models

Developmental theoretical models guiding research into emotional regulation and social competence typically neglect the underlying neurological systems and biological explanations for behavior (Sroufe, 1996). Neuropsychological and cognitive studies often perpetrate a similar neglect (Barkley, 1997b). It is unusual for cognitive scientists to

devote adequate attention to social and emotional factors' contribution to cognitive performance deficits. Despite the traditional practice of conceptualizing cognitive and emotional processes independently of one another, the construct of EC places emotional, cognitive, and behavioral self-regulatory capacities together. As articulated above, these control processes depend upon one another for successful functioning. Emotional and cognitive development and maturational processes are anatomically coevolving in the frontal cortex and in the anterior cingulate cortex (Bell & Wolfe, 2004; Davis et al., 2002; Posner & Rothbart, 2000).

Functional Implications of Insecure Attachment

An insecure maternal attachment relationship in early childhood to a primary care provider may lead to functional disruption(s) including a diminution of behavioral, cognitive and emotional control capacities (Bell & Wolfe, 2004; Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000) resulting in decrements in children's ability to exercise EC, including the inhibition of responses and the control of impulsive urges (Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000). There is evidence that dysfunction of EC processes are core deficits of externalizing disorders and of many mental and personality disorders including: ADHD (Barkley, 1997), Conduct Disorder (Denham et al., 2002; Loeber et al., 1991; Lober & Stouthamer-Lober, 1998), and Obsessive-Compulsive Disorder (Avila et al., 2004; Tamm et al., 2004). Self-regulation deficits such as, impulsivity, and the behaviors associated with an externalizing disorders are particularly troubling in a classroom environment. These behaviors not only interfere with the afflicted student's learning, but the disruption

created by the impulsive student will often detract from other students' educational experience.

Inhibition and self-control deficits significantly contribute to a wide range of intra and interpersonal problems and societal ills. As argued earlier EC deficits are principal characteristics of many societal problems such as criminality (Levine & Jackson 2004), aggression (Dadds et al., 2005), and addiction (Schmidt et al., 2004; Vigil-Colet & Codorniu-Raga, 2004).

Without an adequate exploration of each of the factors that may contribute to the formation of impaired EC, movement towards the development of effective prevention is hampered. The current inadequate and incomplete etiological understanding of executive control dysfunction impedes effective prevention and, as a result, the social costs derived as a consequence of associated disorders will continue to rise until this issue is addressed and resolved.

Conclusion

There is evidence that disrupted early attachment relationships undermine and interrupt the formation of emotional and neural architecture critical to the development of EC capacities related to attentional control, impulsivity, and emotional regulation. The implication of this assertion is significant to future research, prevention, and treatment of executive control dysfunction and self-regulation problems. The suggestion that a real and measurable association exists between early attachment relationships and the eventual formation of EC processes of the executive control system is consistent with the central tenets of Bowlby's (1969) original conception of attachment. He theorizes that social, emotional, and environmental events and conditions inform developing

psychological, biological and neural systems (Bowlby, 1969; Schore, 2000). Similarly, Piaget also believed that an integration of the developmental sciences drawing together findings from psychology, psychiatry, and neuroscience would better explain cognitive function (Cicchetti, 2002; Piaget, 1975).

The following chapter will argue a sufficient theoretical rationale exists to investigate the hypothesis that disrupted early maternal attachment security negatively affects the subsequent development of EC. This argument will be developed by: 1) a discussion of attachment theory, and the meaning of secure and insecure maternal attachment , 2) an overview of current thinking about the general construct executive function with specific attention directed toward defining and explaining the construct of EC, 3) an explication of research linking social, environmental and contextual adversity to negative child developmental outcomes including: higher rates of externalizing disorders, attention problems, and criminal/anti-social involvements (it is critical to note the similarity between these negative outcomes and those linked with poorly developed EC function), and 4) the social, emotional, cognitive, and biological developmental processes antecedent of EC deficits. The review will demonstrate a rationale exists to expect significant differences between the manifest ability of securely and insecurely attached children to exercise EC capacities related to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity.

Research Questions and Hypotheses

This study will explore if securely attached children differ significantly from children who manifest insecure maternal attachment behavior of in regard to their subsequent

formation of EC processes related to attentional control, impulsivity, and emotional regulation, after controlling for the effects of social contextual adversity.

To this end two research questions are explored:

Research Question #1:

Does effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation remain stable from 54 months of age to fourth grade?

Hypothesis #1

Effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age will predict effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade.

Hypothesis #2

Effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age will predict effortfully controlled behavior at fourth grade for boys and girls studied separately.

Hypothesis #3

Children will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade.

Hypothesis #4

Boys and girls studied separately will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade

Research Question #2:

Does security of attachment to a primary care provider at 36 months of age, affect subsequently developed effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, after controlling for the effects of social contextual adversity?

Hypothesis #5

Children that are insecurely attached at 36 months will exhibit more poorly developed effortful controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, than peers that are securely attached at 36 months after taking social contextual adversity into account.

Hypothesis #6

When boys and girls are studied separately, boys and girls that are insecurely attached at 36 months will exhibit more poorly developed effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation, at fourth grade than peers that are securely attached at 36 months after taking social contextual adversity into account.

CHAPTER II

LITERATURE REVIEW

Disrupted early attachment relationships are associated with deleterious emotional, behavioral, and cognitive consequences, such as increased rates of internalizing and externalizing disorders (Kopp, 1989; Fabes et al., 1999; Gross & John, 2003), underdeveloped social competence (Denham et al., 2002; Thompson, 1994), and increased rates of psychopathology such as Oppositional Defiant Disorder, Conduct Disorder, (Denham et al., 2002; Thompson, 1994) anxiety, depression (Gerhardt, 2004), and ADHD (Barkley, 1997). It will be argued that a rationale exists to support the view that insecure attachment to a primary care provider can impact developing neuropsychological (Essex et al., 2002; Gerhardt, 2004; Lyons et al., 2000; Schore, 2001a; Schore, 2001b; Schore, 2001c) and psychosocial systems (Ainsworth, 1989; Beretherton, 1992; Bowlby, 1988; Brazelton & Greenspan, 2000; Karen, 1998) in such a way as to *cause* significant disruption of EC processes of the executive control system related to attentional control, impulsivity, and emotional regulation. It will be further argued that damage to the neural substrates undergirding EC processes of the executive control system contributes to the pathogenesis of many emotional, behavioral, and cognitive disorders.

The notion that disrupted early attachment relationships undermine and interrupt the formation of emotional and neural architecture critical to the development of EC capacities will be supported with evidence gathered by attachment researchers, developmental psychologists, and neuroscientists. This argument will be developed by 1) a discussion of attachment theory and the meaning of secure and insecure maternal

attachment , 2) an overview of current thinking about the general construct, executive function, with specific attention directed toward defining and explaining the construct of EC, 3) an explication of research linking social, environmental and contextual adversity to negative child developmental outcomes including: higher rates of externalizing disorders, attention problems, and criminal/anti-social involvements (it is critical to note the similarity between these negative outcomes and those linked with poorly developed EC function), and 4) the social, emotional, cognitive, and biological developmental processes antecedent of EC deficits. The review will demonstrate a rationale exists to expect significant differences between the manifest ability of securely and insecurely attached children to exercise EC capacities related to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity.

The implications of this assertion are significant to future research, prevention, and treatment of executive control dysfunction and self-regulation problems. The suggestion that a real and measurable association exists between early attachment relationships and the eventual formation of EC processes of the executive control system related to attentional control, impulsivity, and emotional regulation is consistent with the central tenets of Bowlby's (1969) original conception of attachment. He theorizes that social, emotional, and environmental events and conditions inform developing psychological, biological and neural systems (Bowlby, 1969; Schore, 2000). Similarly, Piaget also believed an integration of the developmental sciences drawing together findings from psychology, psychiatry, and neuroscience would better explain cognitive function (Cicchetti, 2002; Piaget, 1975).

Attachment Theory

Attachment Theory or the Ethological Theory of Attachment provides empirical and theoretical support for the notion that children's bond to their parental figure(s) is critical to normal human development, the formation of a sense of self, and emotional regulation (Ainsworth 1989; Bowlby, 1988; Beretherton, 1992; Denham et al., 2002; Diener & Mangelsdorf, 2000). Bowlby (1988) and Ainsworth (1989) define attachment as an important and lasting emotional bond between two people. This bond is specifically crucial between parents and their children. The security or feeling of safety, provided by the attachment connection to an adult care-provider is a fundamental resource for children's burgeoning sense of self (Beretherton, 1992).

One of Mary Ainsworth's vital contributions to attachment theory was the concept of a secure base (Beretherton, 1992; Bowlby, 1988). A secure base allows children to venture into and progress through new developmental ground with the confidence that a place of safety and comfort exists to return to when needed (Rice, Cunningham, & Young, 1997). An equally essential aspect of attachment theory is Bowlby's (1988) notion that an internal working model of the self is formed through a relationship with an adult care-provider. This internal working model is a kind of internalization of the attachment relationship, an internal secure base.

The attachment relationship is a formative experience. Through the attachment bond to a primary caregiver, first impressions of self, and the self's relation to the world are formed (Allen, Hauser, Borman-Spurrell, 1996; Beretherton, 1992; Bowlby, 1988; Liberman, Doyle, Markiewicz, 1999; Rice et al., 1997; Sund & Wichstrøm, 2002). Securely attached children learn that they are loveable, worthwhile, and that the world is

a safe place. Children who suffer insecure maternal attachment s are likely to “develop a working model of themselves as unworthy or incompetent and of others as rejecting or unresponsive” (Lieberman et al., 1999, p.202). The primary attachment relationship serves as a kind of emotional lens through which the self, and the self-in-relation, become known.

Although internal working models are amenable to change with change in the environment, they cannot be modified easily. This is because they involve intrinsically conservative expectations (later experience is interpreted in light of earlier experience) and because these expectancies influence behavior such that expectations are confirmed, or a least not disconfirmed (e.g., someone who expects a rebuff may invite it, thereby confirming expectations, or she or he may avoid interaction, thereby precluding disconfirmation of expectations). (Shneider, Tardif, & Aatkison, 2001, p. 86)

The early attachment bond determines much of how we understand ourselves and interpret others’ actions. Relationship patterns and future experiences in the social, emotional, and academic spheres of life are impacted by the quality of our early maternal attachment. In fact, “attachment theory proposes that the early parent-child relationship serves as the foundation for the emergence of self-regulation skills” (Clarke et al., 2002, p. 181).

Despite some evidence indicating the adverse impacts of disruption to the mother-child attachment relationship more profoundly affects the developmental outcomes of children living with high levels of social contextual stress than low-risk middle class

children (Erickson, Sroufe, & Egeland 1985; Munson, McMahon, & Spieker, 2001; Shaw & Vondra, 1995; Renken, Egeland, Marvinney, Sroufe, & Mangelsdorf, 1989) and the fact that several studies have failed to identify negative behavioral outcomes related to an insecure attachment classification in low-risk middle class children (Bates, Maslin, & Frankel, 1985; Belsky, Hsieh, & Crnic, 1998; Fagot & Kavanaugh, 1990) a vast body of support exist for the notion that primary attachment relationships have life-long consequences. These life-long consequences include: problems with affective and behavioral regulation (Clarke et. al, 2002), social competence, psychological adjustment, and cognitive functioning difficulties (Allen et al.,1996; Beretherton, 1992; Bowlby, 1988; Granot, & Mayseless, 2001; Liberman et al.,1999; Rice et al.,1997; Sund & Wichstrøm, 2002).

Goodness of Fit

Goodness-of-fit is comprised of two important constructs, child temperament and maternal sensitivity. Research seeking to explain the root causes of the differences between children's attachment bond have directed attention primarily to maternal behavior. Although evidence supporting maternal sensitivity as the chief determinant of attachment security is modest, maternal sensitivity remains a central construct to explain why children differ in their attachment relationship at the end of the first year of life (Clark et al., 2000; Goldsmith & Alansky, 1987; Rosen & Rothbaum, 1993; Seifer, Schiller, Sameroff, Resnick, & Riordan, 1996). Perhaps a more useful method to understand the early attachment bond is to examine the reciprocal dynamic between the child and her care-provider. The degree to which child rearing practices and the home environment are consistent with the needs of the child is at the heart of Thomas &

Chess's (1977) goodness-of-fit model. Children's needs vary; this variance in children was referred to by Thomas & Chess (1977) as temperament (McClowry, 2002).

Understanding temperament is vital to understanding goodness-of-fit. The formation of a secure bond between child and care-provider depends upon a multitude of factors. The most critical factor is goodness-of-fit (the degree to which child rearing practices and the home environment are consistent with the child's temperament) (Clark, Kochanska & Ready, 2000; Seifer et al., 1996; Thomas & Chess, 1977). The "goodness-of fit model was explicit in formulating a mechanism by which infant behavioral style influences the nature of interactions with caregivers and transforms the nature of those interactions" (Seifer et al., 1996, p. 15). The reciprocal dynamic between the child and his care-provider is central to the outcome of their relationship (Clark et al., 2000; Seifer et al., 1996; Thomas & Chess, 1977). To better understand the components of the goodness-of-fit model, the research explicating child temperament and maternal sensitivity will be explored.

Child Temperament

Considerable research has been devoted to develop meaningful ways of describing infants' and young children's temperaments. These temperament taxonomies are an important element of attachment theory and goodness-of fit research. A common language is being developed so that complex constellations of behavior can be more easily understood and described. Hundreds of hours of child study are required by researchers who wish to create categories and constructs of temperament. In 2002, McClowry summarized research efforts focused on creating useful systems for describing children's temperament. Her review included the seminal work of Thomas, Chess, and

Birch (1968). Thomas et. al. (1968) described three constellations of behavior or behavioral types derived from longitudinal clinical observations and interviews. Their three behavioral types included: the difficult child, the easy child and the slow-to-warm-up child. Ten percent of the 141 children studied by Thomas et. al. (1968) were described as difficult. Characteristics of the difficult child included: biological irregularity, withdrawal from novel stimuli, slowness to adapt, and an extremely intense and negative mood. The designation easy child was awarded to 40% of the study's 141 participants. The easy child was described as: regular, able to approach new situations with ease, possessing a mild and usually positive mood, and able to adapt easily. Fifteen percent of the remaining children were labeled slow-to-warm-up. These children were high in negative affect, but demonstrated their discontent with less intensity than the children categorized as difficult. Aptly, the children labeled slow-to-warm-up were slow to adapt. In contrast to the difficult children, when the slow to warm up children did acclimate, they showed positive interest. Of the 141 children, 35% did not fit into any of the profiles.

McClowry (2002), upon comprehensively reviewing the literature concerning child temperament, devised a system to categorize the temperament profiles of (four to twelve-year-old) children. The children represent a diversity of gender, race/ethnicity and socioeconomic status. Her system included six temperament types: High Maintenance (8%), Cautious/ Slow-to-Warm-Up (8%) Both High Maintenance and Cautious/Slow-to-Warm-Up (6%), Industrious (6%), Social/ Eager to Try (9%), and Both Industrious and Social/ Eager to Try (4%). The remaining 59% of the participating children failed to meet criteria for any of the above six categories.

It is important to note that children vary in the ways they interact with the world. Their actions have an impact upon their care givers and their care givers have an impact upon them. Children's temperament impacts the way they are responded to by their caregivers. Difficult or High Maintenance children are responded to differently than their less reactive peers. Considerations such as: culture, familial stress, poverty and most importantly, the sensitivity of the primary caretaker are powerfully influential to children (Clark et al., 2000; Seifer et al., 1996).

Maternal Sensitivity

Provoking continued debate among attachment researchers is the question: to what extent is the attachment bond dependant upon maternal sensitivity? Paternal sensitivity has not received the same level of attention in the literature. Maternal sensitivity is the measure of the mother's "alertness to infant signals, appropriate interpretation of responses, promptness of response, flexibility of attention and behavior, appropriate level of control, and negotiation of conflicting goals" (Seifer et al., 1996, p. 15). Ainsworth, Blehar, Walters & Wall (1978) began a long standing dispute by asserting the criticality of maternal sensitivity as a "key variable in predicting attachment status" (Seifer et al., 1996, p. 15). Replications of Ainsworth et. al.'s (1978) findings have been inconsistent, and some attachment theorists dispute the view that maternal sensitivity is an essential variable in predicting attachment status. These dissenters suggest infant temperament contributes greater variance than does maternal sensitivity to the prediction of attachment security. For example, Seifer et al. (1996) concluded that "maternal sensitivity was only weakly related to attachment status" (Seifer et al., 1996, p. 20). Her team found that infant temperament was a better predictor of attachment status than maternal sensitivity.

They also demonstrated that a relationship exists between infant temperament and maternal sensitivity.

Undoubtedly, infants who manifest a difficult temperament present greater challenges to their care-providers than their more docile counterparts. Maternal sensitivity, however, is predicated upon the mother's ability to successfully modulate the level of environmental stimulus, so as to adequately match the infant's need for stimulation and soothing no matter how difficult that task. "Infants are initially dependent on the caregiver's ability to provide containment and regulation of their psychophysiological states, with the development of self-regulatory capacities viewed as contingent on the sensitive responsiveness of the caregiver to infant signals (Cassidy, 1994; Field, 1994)" (Clarke et al., 2002, p. 181). From this vantage, the role of maternal sensitivity is unequivocally connected to attachment security.

The goodness-of-fit model is predicated upon the notion of a reciprocal dynamic between mother and child. Temperament and the sensitivity of the care-provider contribute to the development of the attachment relationship. The goodness-of-fit between the care provider and the infant is the most fundamental aspect in determining attachment (Clark et al., 2000; Seifer et al., 1996; Thomas & Chess, 1977).

Attachment Security

The quality of the young child's attachment bond to a care-provider is often discussed in terms of the security of the bond. As a part of her 1963 longitudinal observation of mothers and infants in Baltimore, Maryland, Mary Ainsworth developed a procedure called the "Strange Situation." The "Strange Situation" procedure was designed to examine infants' utilization of their care-providers as a secure base.

Ainsworth noted that children's reaction to the "Strange Situation," particularly reunion behavior, varied based upon the strength of the child's bond to the attachment figure (Ainsworth et al., 1978; Brisch, 2002). The "Strange Situation" experiment generated observational data to support the creation of a system for describing the quality of the infant's attachment bond to its primary care-provider that is the most widely accepted and used system to date.

Ainsworth and her colleagues generated three categories into which they sorted children based upon the behavior observed during the "Strange Situation" experiment. Children identified as "Securely Attached" clearly demonstrated attachment behavior when reunited with their mothers, subsequent to their first and their second separations. Children identified as "Securely Attached" call out, attempt to follow, seek, and become upset in the absence of their mothers. These children respond to mothers' return by manifesting positive emotion, the desire to be held, and seeking consolation. They benefit from contact with their care-provider, quickly regain equilibrium and return to play.

Children who meet criteria for the "Insecure Avoidant" classification are less distressed by separation from their mothers, than their securely attached counterparts. These "Avoidant" children do not display the attachment behaviors that characterize children in the "Securely Attached" category. They don't call after their mother after she departs, follow her to the door, or search for her. They will follow her departure with their eyes, and often their play becomes more constricted in her absence. The hallmark "Avoidant" response occurs when mothers return to the playroom. "Avoidant" children respond to the reunion by eschewing physical contact. These children do not reach out to be held or seek consolation from their mothers.

The children Ainsworth and her colleagues dubbed “Insecure Ambivalent” were the most distressed of the three groups when separated from their mothers. “Insecure Ambivalent” children have the most difficulty regaining emotional stability. These children generate powerful displays of attachment behavior, cry when separated, reach out to be held, but when responded to, react with resistance and displays of anger. They kick, hit and arch their backs when the care provider tries to hold them to offer comfort and consolation. These children are labeled “Ambivalent” because they appear to desire comfort, but are often too angry to benefit from contact and soothing.

Main and Solomon (1990) introduced a fourth descriptor within the taxonomy created by Ainsworth et al. (1978). They labeled the taxon “Insecure Disorganized/Disoriented.” This category is frequently applied to the most disadvantaged children, or youngsters belonging to clinical high-risk groups. Children classified “Disorganized” exhibit confused response to reunions with their care-providers. They behave in contradictory ways. They run toward their mother, stop before reaching her, and then run away. They freeze, exhibit stereotypic or repetitive behaviors, and are sometimes aggressive. Children classified “Disorganized” are considered the most negatively impacted by attachment stress. They have often been subjected to neglect and/or abuse.

An area of developing interest includes the assessment of the attachment security of preschool children using the “Strange Situation” procedure. Several studies have explored the validity of the preschool Strange Situation classifications developed by the MacArthur Working Group on Attachment (MacArthur; Cassidy & Marvin and the MacArthur Working Group on Attachment, 1992) when applied to preschool populations.

The MacArthur coding system classifies preschoolers as secure (B) or insecure (A, C, and D). Secure (B) children are able to resolve the stress of the separation and resume calm, comfortable interaction with the parent. Insecure-avoidant (A) children maintain extreme neutrality toward the parent, and even after reunion rarely express either positive or negative emotion toward the parent. Insecure-ambivalent (C) children show fussy, helpless, whiny, and/or resistant behavior toward the parent. They may seek contact, but find it unsatisfactory. Insecure-controlling/insecure-other (D) children are either controlling or show combinations of strategies, such as avoidance and ambivalence, or avoidance and controlling behavior, during the reunions. Controlling children take charge of the reunion, usually in either a caregiving (role-reversal) or punitive manner. A child showing more than one type of controlling behavior is classified as controlling-general. Coders also make a global 9-point security rating, in which 1 = Very insecure, 3 = Insecure, 5 = Probably secure, 7 = Secure, and 9 = Very secure. (NICHD, 1999, p 189).

Several studies examining preschool Strange Situation classifications were conducted drawing upon convenience samples of typically functioning low risk preschool populations (Cassidy, Berlin, & Belsky, 1991; Greenberg & Slough, 1991; Stevenson-Hinde & Shouldice, 1992) and in some cases convenience samples of high risk low income minority preschool populations (Barnett, Kidwell, & Ho Leung, 1998). Additionally, several studies have conducted their analyses comparing high risk groups to typical populations (Booth, Rose-Krasnor, McKinnon, & Rubin, 1994; Cicchetti &

Barnett, 1991). These studies produced results consistent with theoretically derived hypotheses lending credence to the validity of the MacArthur coding system.

Preschool attachment classification is correlated with the evaluated children's behavioral outcomes and maternal behavior. Booth et al. (1994) examined the predictive validity of preschool attachment classification by examining a heterogeneous sample of 79 children. They studied children's social adjustment outcomes with a longitudinal design. They found "attachment security at age four was the strongest predictor of internalizing problems and social engagement/acceptance at age eight" (Booth et al., 1994, p. 189) and maternal parenting style was the best predictor of externalizing behavioral difficulties.

Another example of a study illustrating the validity of preschool attachment classification was conducted by Demulder and Radke-Yarrow (1991). They tracked and compared a sample of clinically depressed mothers and control mothers, 112 mother-child dyads in all. Results indicate secure preschoolers' mothers demonstrated relatively more displays of affection and more neutral-pleasant affect as compared to mothers of insecure preschoolers. Additionally, secure preschoolers' mothers demonstrated less downcast affect, compared with mothers of insecure preschoolers.

Further indication of the validity of the Strange Situation classifications developed by the MacArthur Working Group on Attachment Assessment is provided by Barnett et al. (1998). Their study of a sample of 69 four to five-year-old urban, economically disadvantaged, African-American families indicated that the parents of preschool children rated as securely attached evidenced comparatively more warm and accepting behavior than did the parents of insecurely attached children. Parents of insecurely

attached children demonstrated a relatively greater number of instances of controlling behaviors, and were more likely to employ physical (corporal) punishments, as well as offering fewer verbal corrections than did parents of securely attached children.

Attachment security is most often assessed for the infant and preschool in age groups with the well validated strange situation procedure. The strange situation procedure involves behavioral observations of children's responses to separations and reunions with their caregiver (Ainsworth et al., 1978). Reunion behavior in particular is thought to be a reflection of children's internal working models of the attachment relationship (Clarke et al. 2002).

Executive Function & Effortful Control

Executive function is an umbrella concept to describe “higher order” cognitive skills and abilities required for controlling and coordinating performance in the face of social, emotional and cognitively complex and demanding tasks (Alexander & Stuss, 2000; Andrews, 2001; Baddeley, 1997a; Barkley, 1997b; Baron, 2004; Klenberg et al., 2001; Leon-Carrion et al., 2004; Shachar & Logan, 1990; Lezak, 1995; Norman & Shallice, 1986; Wu et al., 2002). Executive control functions are core “executive functions” (Alexander & Stuss, 2000; Stuss & Alexander, 2000) simply because the control systems facilitate the differential activation and deactivation of a range of “higher order” cognitive and emotional functions (Davis, Bruce, & Gunnar, 2002; Miller, 2005; Posner, 1995; Posner & Rothbart, 1998) including: attentional focusing, self monitoring, cueing the initiation of effort, inhibitory and activational control, response inhibition, planning, mental flexibility, working memory, and self-regulation (Alexander & Stuss, 2000; Andrews, 2001; Baron, 2004; Davis et al., 2002; Eisenberg & Spinrad, 2004; Lezak,

1995; Rothbart et al., 1994; Rothbart & Bates, 1998; Posner, 1995; Posner & Rothbart, 1998). Stuss and Alexander (2000) emphasize a critical point regarding the conceptualization of executive function(s), namely: “there is no frontal homunculus, no unitary executive function” (p.291). By positing that no single master control center exists, Stuss and Alexander are not suggesting that no control system exists, only that the system is comprised of multiple independently functioning “regulators.” Each regulator governs a distinct function while working in concordance with the other regulators to maintain organized, goal directed, and self-regulated behavior (Alexander & Stuss, 2000; Stuss & Alexander, 2000).

EC is a construct employed to describe aspects of the executive control system. As stated earlier, the construct of EC is uniquely useful because it combines emotional, cognitive, and behavioral self-regulatory capacities (Davis et al., 2002; Eisenberg & Spinrad, 2004; Posner & Rothbart, 2000; Rothbart, 1989; Rothbart & Bates, 1998; Rothbart, & Ahadi, 1994; Rothbart et al., 1994; Rothbart et al., 2003). EC is meant to refer to emotional, social, and cognitive regulatory function, with the understanding that the separation of emotional, social, and cognitive developmental processes is an artifact of the fractionization of psychology, rather than an organically based distinction.

Though EC is a construct developed by Rothbart and colleagues as part of their work on temperament (Rothbart, & Ahadi, 1994; Rothbart & Bates, 1998; Rothbart et al., 1994; Rothbart et al., 2003), the utility of conceptualizing emotional, social, and cognitive control processes together as a unitary notion that is salient to developmental outcomes beyond early childhood is unmistakable. Evidence supports the notion of interdependence between emotional, social, and cognitive systems (Bell & Wolfe, 2004;

Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000). A consequence of serious dysfunction in any one of these domains (emotional, social, or cognitive) will most often result in decrements to self-regulatory and executive functioning (Cicchetti, 2002). For this reason the construct of EC is here extended upward to pertain to and describe emotional, social, and cognitive control processes through early adolescence. This upward extension of Rothbart and Bates (1998) temperament construct will hopefully aid in the quest to develop a better understanding of psychopathology and the developmental pathogeneses of numerous disorders related to attention, executive function and conduct (Nigg et al., 2004).

Optimal EC function is associated with effective self-regulation, emotional-regulation, adaptability, flexibility, inhibition of response (impulse control), and attentional control (Davis et al., 2002; Murray & Kochanska, 2002; Posner, 1995; Posner & Rothbart, 1998; Rothbart & Bates, 1998). Conversely, diminished EC functioning is associated with poor or ineffective self-regulation, inattention, impulsivity, diminished mental control, hyperactivity, aggression, disorganization, and emotional lability.

Rothbart and Bates (1998) developed the notion of EC and defined it as “the ability to inhibit a dominant response to perform a subdominant response” (p.137). In a personal communication on January 26, 2002, Rothbart defined EC as “efficiency of executive attention, including the ability to inhibit a dominant response and/or to activate a subdominant response, to plan, and to detect errors” (as cited by Eisenberg & Spinrad, 2004, p.337).

The construct of EC has several dimensions and many definitions. Eisenberg & Spinrad (2004) suggest that “EC is reflected in effortful attentional regulation — the

abilities to voluntarily focus or shift attention as needed in a given situation — as well as in inhibitory and activational control — the abilities to effortfully inhibit behavior or activate behavior as needed” (p. 337). Posner & Rothbart (2000) defined EC more broadly; they derive their definition of EC from factor analysis of the Children's Behavior Questionnaire (CBQ; Rothbart et al., 1994). Their definition of EC includes: “attentional focusing, inhibitory control, low intensity pleasure, and perceptual sensitivity” (p. 435). They also suggest “EC provides the attentional flexibility needed to link negative affect, action outcomes, and moral principles” (p. 435). Fabes et al., (1999) in an attempt to explicate the four subscales of the CBQ which load upon the construct of EC provides a description of each dimension.

Inhibitory Control — The capacity to plan and suppress inappropriate responses under instructions or in novel or uncertain situations (e.g., Is good at games like “Simon Says,” “Mother, May I.”).

Attentional Focusing — tendency to maintain attention on task-related channels (e.g., “When drawing or coloring in a book, shows strong concentration.”)

Low Intensity Pleasure — Amount of pleasure or enjoyment related to situations involving low stimulus intensity, rate, complexity, novelty, and incongruity (e.g., “Enjoys looking at picture books.”)

Perceptual Sensitivity — Amount of detection of slight, low intensity stimuli from external environment (e.g., “Notices the smoothness or roughness of object she/he touches.”). (Fabes et al., 1999, p. 435)

Davis et al., (2002) write that “EC is the capacity for active, voluntary inhibition or modulation of response. It is the ability to purposefully regulate behavior, to inhibit a proponent response, or to resist interference” (p.43).

Though the construct of EC has several definitions, a consensus exists that the construct of EC pertains to the differential activation and deactivation of a range of cognitive and emotional executive control functions (Davis et al., 2002; Murray & Kochanska, 2002; Posner, 1995; Posner & Rothbart, 1998) including: attentional focusing and control, inhibitory and activational control, response inhibition, planning, mental flexibility, affect regulation, and self-regulation (Davis et al., 2000; Eisenberg & Spinrad, 2004; Rothbart et al., 1994; Posner, 1995; Posner & Rothbart, 1998; Rothbart & Bates, 1998).

These cognitive and emotional control processes co-develop and remain linked in function throughout development. An example of the interdependence of EC functions is made clear by the example of planning. The execution of planful behavior requires: activational control to direct mental resources toward the task, attentional control so the task can be apprehended and considered fully, emotional and impulse control so the plan can be implemented in order without one becoming sidetracked, and planning so the tasks can be organized and sequenced appropriately. Successful human functioning is dependant upon EC. These co-evolving executive control functions are inextricably and anatomically bound in the frontal cortex and in the anterior cingulate cortex (Bell & Wolfe, 2004; Davis et al., 2002; Posner & Rothbart, 2000).

Recent research into the anterior cingulate cortex reveals its dual function as a regulator of attention, cognition, and emotion (Bell & Wolfe, 2004; Davis et al., 2002).

Theories promoting this connection between attention, cognition, and emotion are consistent with much of Cohen's (1993) work identifying types of "neural inhibition." Cohen's (ibid.) "unidirectional inhibition" appears to mirror the notion advanced by Davis et al., (2002) of an anterior attention network linking cortical (frontal) and subcortical structures including the HPA system. Unidirectional inhibition like the concept of EC pertains to the ability to "control behavior ... maintain arousal and self-monitoring of behavior (self-control)" (Riccio, Reynolds, Lowe, & Moore, 2002, p. 241). This connection is important because Riccio et al., (2002) suggest that the Continuous Performance Task is a measure of unidirectional inhibition. The conclusion of these findings is that the development of effortful self-regulation and control capacities is an integrative process incorporating emotional, social, and cognitive developmental processes. For the purposes of this study only effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation will be examined.

Gender and Effortful Control

A considerable accumulation of evidence exists indicating boys and girls differ in regard to their capacity to exercise effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation (Else-Quest et al., 2006). Girls consistently outperform boys on attentional measures and measures of behavioral control (Carlson et al., 1997; Else-Quest et al., 2006; Pasco-Fearon & Belsky, 2004; Gaub & Carlson, 1997; Johnson et al., 1999; Kochanska & Knaack, 2003; Levy et al., 2005). The preponderance of evidence comparing girls to boys has been accumulated under the auspices of ADHD research and investigations of ADHD comorbidity. Boys referred by clinics are more likely to meet ADHD diagnostic criteria than girls (Johnson et al., 1999). ADHD

identified girls are more likely to exhibit comorbid internalizing disorders (often anxiety) (Levy et al., 2005) and social impairment (Carlson et al., 1997), whereas ADHD boys more often manifest externalizing disorders. These ADHD boys are consistently perceived as more aggressive, hyperactive, and oppositional and defiant than their female counterparts (Johnson et al., 1999; Levy et al., 2005). Research examining sex differences among non-referred children's attentional and effortfully controlled behavior reveals a similar result. Girls consistently, across studies, outperform boys at attentional and EC tasks (Else-Quest et al., 2006; Pasco-Fearon & Belsky, 2004; Kochanska & Knaack, 2003; Rothbart et al., 2003). For example, Else-Quest et al., (2006) employed meta-analytic techniques to 205 published studies investigating temperament. They examined gender differences across three temperamental factors, from children aged three months to thirteen years. A principal finding of their meta-analysis revealed a large gender difference favoring girls' EC capacity related to attentional control, impulsivity, and emotional regulation.

The above cited research provides ample reason to believe girls manifest significantly different developmental trajectories regarding the formation of effortfully controlled behavior than boys. It is therefore reasonable to study boys' and girls' capacity to exercise effortfully controlled behavior independently from one another.

Social Contextual Adversity and Effortful Control

An all but overwhelming body of evidence has been compiled supporting the contention that all behavior is influenced by some combination of genetic and environmental factors (Beiderman et al., 1992; Beiderman et al., 1995; Rutter & Sroufe, 2000). Little doubt exists that biological/genetic factors and environmental/psychosocial

contributions play a role in the development of psychopathology (Cicchetti, 2002; Rutter & Sroufe, 2000). Developmental psychopathology researchers, however, have endeavored in vain to provide definitive answers to two critical questions, 1) “To what extent are children’s behavioral outcomes dependent upon biological/genetic causation versus environmental/psychosocial contributions?” and 2) “Which environmental/psychosocial factors most profoundly impact child development?” Debate over these questions is particularly heated in regard to providing explanations for the pathogenesis of externalizing disorders and the formation of problems of self-regulation and EC such as those described by the symptoms of ADHD (Clarke et al., 2002; DSM-IV-TR, 2000).

Biological/Genetic Causation versus Environmental/Psychosocial Etiological Explanations of Poor Effortful Control

Researchers are unable to conclusively establish a definitive set of factors or chain of events that lead to the formation of ADHD (Barkley, 1997b). Despite this etiological uncertainty, most current research has predominantly focused on biological/genetic causative pathways (Barkley, 1997b; Pennington & Ozonoff, 1996). Barkley, (1997b) in declaring the evidence in support of a “purely psychological or social etiology of ADHD” (p. 30) “weak or lacking entirely” (p.29) devotes scant attention to this issue. Citing Goodman and Stevenson’s (1989) twin studies, Barkley (1997b) contends the genetic/biological contribution to the primary formation of the pattern of neuropsychological decrements associated with ADHD represents between 85-90% of the variance, suggesting social/environmental factors (e.g. parenting, peers, school, community) contribute something less than the remaining 10-15% of variance. Barkley’s

(1997b) concession to social environmental influence is the recognition that the severity of ADHD symptoms can be mediated by social environmental factors. To summarize his position, Barkley believes the accumulated evidence suggests social environmental factors are weakly linked to primary causation of ADHD symptoms, but social environmental considerations can importantly impact children's outcomes (Beiderman et al., 1995; NIHCD, 2003; NIHCD 2005A; NIHCD 2005B; Olson et al., 2002), specifically, outcomes related to the formation of comorbid conditions such as: oppositional defiant disorder, conduct disorder, anxiety, and depression (Barkley, 1997b).

Barkley's position fails to account for the growing body of evidence indicating early relational trauma and environmental stress can impact neural development (Lyons et al., 2000; Essex et al., 2002; Schore, 2001a; Schore, 2001b; Schore, 2001c; Gerhardt, 2004). Cicchetti (2002) and others (Cicchetti & Tucker, 1994; Eisenberg, 1995; Gerhardt, 2004; Schore, 2001c; Olson et al., 2002) provide a clear articulation of the complexities inherent in predicting behavioral outcomes when considering the interaction between our genetic predisposition and our social experiences. Environmental experience significantly contributes to the phenotypic expression of a child's growing brain (Cicchetti & Tucker, 1994; Eisenberg, 1995).

The significance of Barkley's failure to give adequate consideration to the complex recursive relationships between social experiences and neural development is twofold. Primarily and simply, Barkley's estimation of the amount of variance contributing to the etiology of ADHD by social environmental factors may be misguided, (perhaps by a great deal) because he dismissed social environmental factors as unrelated to biological neural developmental considerations.

Secondarily, by failing to adequately account for the impact(s) of social and environmental experience on neural development, Barkley overlooks a set of pathogenic processes which may significantly contribute to a more definitive comprehension of factors and events that lead to the formation of ADHD symptoms. (A thorough explanation of the specific neural structures and systems responsible for self-regulation and executive control, and the mechanisms by which social environmental experiences impact neural development are provided in the next section). In sum, no clear and defensible accounting exists explaining the relative contribution of biological/ genetic causation versus environmental/psychosocial causation to the pathogenesis of externalizing disorders and the formation of problems of self-regulation and EC.

Environmental and Psychosocial Contributions to the Pathogenesis of Poor Effortful Control

Regardless of the fact that researchers cannot agree upon an exact accounting of the variance or pathogenetic process that accounts for the impact of environmental and psychosocial contextual factors contribution to the development of externalizing disorders and problems of self-regulation and EC, the critical role of the child's early environment and psychosocial context upon subsequent developmental outcomes is widely accepted (Bronfenbrenner, 1979; Bowlby, 1969; Cicchetti, 2002; Rutter & Quinton, 1977; Rutter & Sroufe, 2000; Vygotsky, 1978). In fact, the preponderance of evidence supports the notion of a strong positive relationship between social contextual stress (NICHD Early Child Care Research Network, 2003; Belsky & Pasco-Fearon, 2002; Biederman et al., 1995; Rutter & Sroufe, 2000) and the functions described by the construct of EC.

It is argued that a rationale exists to support an investigation of the effects of insecure maternal attachment, while controlling for the effects of social contextual adversity. A strong and growing literature supports the contention that children's attentional capacity and ability to exercise EC related to impulsivity and emotional regulation is negatively impacted by adverse environmental and psychosocial circumstances (Clarke et al., 2002; Fabes et al., 1999; Fox, 1994a; Gross & John, 2003; Kopp, 1989; Landry et al., 2000; Landry et al., 2002). Several recent publications by the NIHCD Early Child Care Research Network (2003, 2005a, 2005b) have demonstrated there exist associations between children's school readiness, ability to sustain attention, control impulsive urges, and a variety of indicators of social adversity, including: familial environmental factors, socioeconomic status, and the sensitivity of their care providers. A vast literature exists linking poverty (Bradley & Corwyn, 2002; Costello et al., 2003), harsh or coercive parenting (Gartstein & Fagot, 2003; Lecuyer-Maus, & Houck, 2002; Morrell & Murray, 2003), maternal mental illness (Biederman et al., 1995), child abuse (Dodge, Pettit, Bates, & Valente, 1995), neglect and maltreatment (Higgins & McCabe, 2003; Cicchetti, 2004) to externalizing disorders and symptoms consistent with an impaired ability to exercise EC.

Hughes and Crothers (2007) provide a clear articulation of three explanatory models (Additive Models, Interactive Models, and Transactional-Ecological Developmental Models) each providing an accounting of the way psychosocial contextual factors contribute to the pathogenesis of externalizing disorders. Each of these models is well supported and researched, but the models vary in complexity. The central idea of each of these explanatory models will be briefly discussed.

Additive models.

In 1975, Rutter, Cox, Tupling, Berger, and Yule suggested and provided compelling evidence that the aggregate of multiple social contextual adversity factors best predict mental illness and negative outcomes, rather than any single psychosocial contextual risk factor. Rutter's cumulative risk model was strengthened by continued (Rutter & Quinton, 1977) work studying children raised on the Isle of Wight (a rural sample) and children growing up in the urban social context of London, England. Rutter's team identified six social contextual risk factors that were associated with behavioral and emotional disturbance regardless of their broader environmental context: 1) low socioeconomic status, 2) marital disruption, 3) large family, 4) paternal criminal involvement, 5) maternal mental illness, and 6) out of home placement. Others have contributed to advancing this view that it is the number of adverse environmental risk factors that best predict subsequent antisocial behavior. An example of research supporting the predictive power of concurrently taking into account multiple contextual risk factors includes Deater-Deckard, Dodge, Bates, & Petit's (1996) work which examined the predictive power of an array of 20 dissimilar social contextual, genetic, and environmental risk factors effecting children during their preschool years. Deater-Deckard's team found a weak but significant relationship between various individual risk factors and the onset of conduct disorder five years later. Importantly, when the cumulative impact of multiple risk factors was calculated, results indicated as much as 50% of the variance in the onset of externalizing problems could be explained.

More recent research has produced findings consistent with Rutter and Quinton's classic work (1977). Gartstein & Fagot's (2003) hierarchical regression models showed a

negative correlation between children's EC at age five and parental self endorsement of depressive symptoms, and observations of marital turmoil and coercive/harsh parenting practices. Barkley's (1997a) position is consistent with the work of Rutter and Quinton (1977), as is the work of Beiderman et al., (1995) Liaw & Brooks-Gunn (1994), Sameroff et al. (1993) and Rutter & Sroufe (2000). These authors' findings are supportive of the general conclusion that it is the aggregate of multiple social contextual adversity factors in the environment, that impact developmental outcomes of children suffering from EC dysfunction related to attentional control, impulsivity, and emotional regulation, rather than one single adversity factor (Rutter, 2000; Rutter & Sroufe, 2000; Sameroff, 2000).

Interactive models.

The principal notion advanced by proponents of the interactive models is that particular risk factors are more or less virulent when combined with specific risk or resiliency factors. Simply put, some risk factors become more dangerous only when paired with other risk factors. On the other hand, many risk factors are moderated by particular resiliency factors. For example, Pasco-Fearon & Belsky conceived of secure attachment as a mediator/protective factor guarding against the risks associated with being male and contending with social contextual adversity. They hypothesized, "(a) that individual differences in attachment security are associated with variations in attentional performance and related behavior and (b) that secure attachment would protect children from risk associated with being male and growing up under less support of contextual conditions"(p. 1688). Their results indicated that four (4) ½ "year-olds with secure attachment histories would be protected from anticipated risks to attentional performance (CPT) associated with being male and growing up under conditions of high contextual

risks.” This sort of diathesis-stress model is now well supported. Another example is research by Pettit, Laird, Bates, & Dodge (1997). They demonstrated that the social and environmental risk associated with poverty may be moderated by adequate parental supervision. An ample research base supports the notion that specific risk factors may interact to the detriment of children’s EC function and the onset of externalizing problems and conversely that specific resiliency factors may significantly moderate the negative impact of particular risk factors.

Transactional-ecological developmental models.

Clearly a substantial empirical base exists supporting both the additive and interactive models. However, these models fail to offer a developmental explanation detailing the specific pathogeneses leading to externalizing problems and decrements to executive control function. The central intention of any Transactional-Ecological Developmental model is to construct an understanding of the reciprocal interaction between the social environment and the child. This reciprocal interaction is viewed as impacting and shaping both the child’s developmental outcomes and contributing to the outcome of the social environment (Bronfenbrenner, 1986; Fabes et al., 1999; Sameroff, 1995; Sroufe, 1996). Such models tend to be exceptionally complex because development is viewed as a dynamic transaction whereby the environment informs the maturational process of the child and the growing child in turn influences his environment (Cicchetti, 2002; Sroufe, 1996). In fact the argument advanced in the following section is a transactional-ecological developmental model. The hypothesized pathogenic process model presented by this study details the developmental trajectory of children who do not benefit from a secure maternal attachment.

Though clearly Transactional-Ecological Developmental models offer the best explanation of the impacts of environmental stressors, the intention of this study is to isolate the variance contributed by insecure maternal attachment to subsequent EC function. The strength and abundance of the above cited research provides ample reason to investigate the effects of the attachment relationship in isolation from the potentially confounding consequences of other social contextual adversity factors proven to be deleterious to children's developing neuropsychological and psychosocial functioning. The most effective means of achieving this goal is to employ an additive model to create a cumulative social contextual risk index score that can be employed as a covariate.

The Link Between

Attachment Insecurity and Effortful Control

There are two distinct, yet overlapping rationales supported by the literature, regarding the relationship between attachment, and the development of EC related to attentional control, impulsivity, and emotional regulation. The first rationale accounts for the emotional and social developmental antecedents of EC deficits. The second rationale concerns the cognitive and neural developmental antecedents of decrements to EC. That two autonomous but overlapping rationales exist should not be surprising, because "from the very start, Bowlby contended that a deeper understanding of the complexities of normal development could only be reached through an integration of developmental psychology, psychoanalysis, biology, and neuroscience" (Schoore, 2000, p. 203).

Bowlby's position holds that a secure parent-child attachment relationship, and the formation of a benign internal working model in early childhood is central to the development of a child's conception of self, and self in relationship. A well developed

internal working model of the self is an indispensable developmental milestone along the path towards self-regulation. It is obvious without a well developed conception of self, self-regulation is quite impossible. What would exist to be regulated? Failure to establish a repertoire of affective knowledge and strategies to mediate the intensity, duration, and valence of emotion is imperative. A lack of affective knowledge and emotional regulation strategies contribute to social rejection, increased stress, the development of externalizing behavioral disorders, and psychopathology such as oppositional defiant disorder and conduct disorder (Denham et al., 2002; Thompson, 1994).

This developmental neurobiological explanation of the consequences of insecure attachment regarding the development of EC is complex. The second of these two rationales provides an account of the neural developmental antecedents of EC deficits related to attentional control, impulsivity, and emotional regulation. The complexity concerns numerous hierarchically organized systems of neural circuitry responsible for the regulation and control of emotions, social behavior and cognition. These systems are universally underdeveloped at birth (Schor, 2001b; Gerhardt, 2004). Schor (2001a, 2001b, 2001c) posits that the development of adaptive right brain regulatory capacities are experience dependent. He asserts the necessary experiences for optimal development occur in the context of a secure attachment relationship with a primary care provider. Schor's (2001a, 2001b, 2001c) "experience dependent maturation" suggests that critical brain structures, as well as the neural circuitry connecting and comprising the hierarchical relationships necessary for effective self-regulation are formed by the nature and kind of experiences to which the infant is exposed. The downside of this generally adaptive trait is that in some unfortunate circumstances, such as, child neglect, relational trauma, or

insecure attachment, the amount of environmental exposure to situations conducive to brain development is inadequate. When opportunities for the development of brain structures that foster normal functioning are lacking, pathology results. Additionally, chronic exposure to negative experiences, such as, insecure attachment to a primary care provider, has repeatedly been demonstrated to result in the overproduction of the stress hormone cortisol, via (Essex et al., 2002; Spangler & Grossman, 1993) the hypothalamus pituitary adrenal (HPA) axis or stress response (Gerhardt, 2004; Schore, 2001b).

Essex et al., (2002) explored the hypothesis “that exposure to high levels of maternal stress during infancy sensitizes children to later stress exposure” (p. 777). They predicted children with a history of early stress exposure who were concurrently exposed to maternal stress would manifest behavioral symptoms and increased cortisol levels. They also considered socioeconomic status as a contributing to children's HPA functioning. From the 282 families included in the analysis, 135 boys and 147 girls were studied. Cortisol levels of the children were measured via saliva samples collected by their parents in the home, on two of three consecutive collection days. Longitudinal analysis with repeated assessments of maternal stress indicated that “maternal stress beginning in infancy predisposes children to increased HPA function during a period of concurrent stress. Importantly, the data show the children exposed to higher levels of concurrent stress without a history of early stress exposure did not have elevated cortisol levels” (Essex et al., 2002, p.781).

Overproduction of cortisol has been linked to decrements of EC processes related to emotional control (Fox, 1994), attentional processes (Lupien & McEwen, 1997; Mendl, 1999), cognitive processes, including learning and memory (Bell & Wolfe, 2004; Cole,

Martin, & Dennis, 2004), and control of inhibition and impulsivity (Gerhardt, 2004; Lyons et al., 2000; Schore, 2001a).

Emotional and Social Developmental Antecedents of Effortful Control Deficits

Most developmental theorists agree emotional regulation is developed in the context of socialization experiences beginning at birth (Lefreniere, 2000). These socialization experiences lay the foundations for the child's internal working model of self, and self in relation. For example, Sroufe (1996) proposes a three tiered organizational scheme, whereby "caregiver-guided regulation" of the infant is the predominant regulation mechanism from birth to six months. Sensitive and responsive care-providers who offer a well regulated environment during the first six months of the child's life are nearly universally regarded by developmental theorists as contributing to the development of self regulatory capacities (Beretherton, 1992; Bowlby, 1988; Tronick, 1989; Kopp, 1989). Care-providers, who consistently offer appropriately sensitive and responsive nurturance, effectively assuage physiological tension and stress. They offer psychological as well as physical comfort, soothing and appropriate levels of positive stimulation. In short, these care-providers offer a secure base from which the infant can safely explore her surroundings. The secure infant is confident in the knowledge that she will be effectively soothed and comforted upon return to her care-provider. Continued exposure to an appropriately sensitive care-provider allows the child to form a benign internal working model of the self, and the self in relationship to the world. Such children do not experience excessive stress, and form an organized and integrated internal picture of themselves and their environments (Olson, Bates, Sandy, & Schilling, 2002).

As “caregiver-guided regulation” becomes less of a physiological necessity because of biological and maturational changes that begin to occur around six months of age “guided self-regulation” takes over. Sroufe’s (1996) notion of “guided self-regulation” relies on regulatory strategies and competencies being cultivated through observation and interaction with adult social models. Lev Vygotsky (1978) suggested that new skills and aptitudes are best acquired in the context of a supportive environment; an environment where competent adults provide a framework for children so they may stretch the limits of their competence and engage in more advanced behaviors. Vygotsky’s notions of “scaffolding” and of a “zone of proximal development” pertain to social and emotional development, as well as the acquisition of academic knowledge. Vygotsky (1978) postulated that a child can perform a task or behavior with adult guidance or peer collaboration that she could not alone achieve. Vygotsky’s theories have serious implications for the developmental stage of “guided self-regulation.” When socially and emotionally competent care-providers scaffold difficult emotional experiences for the children in their care, they foster the development of self-regulation and control. In this way, children develop a repertoire of coping strategies and competencies. Perhaps more importantly such children develop a notion of themselves as fundamentally capable of managing their environments. With practice and continued support, preschool children eventually function more autonomously (Landry, Smith, Swank, & Miller-Loncar, 2000; Landry, Miller-Loncar, Smith, & Swank, 2002).

Landry et. al. (2000) employed structural equation modeling to discover if common paths of influence exist between two distinct parenting styles, *maintaining* and *directiveness* and children's cognitive and social skills at 2 and 3 ½ years of age regarding

the development of goal directed and social initiating skills at 4 ½ years. Landry's team studied 104 full-term and 185 pre-term children. Although Landry's study did not address insecure attachment or the development of EC, it addressed interactional dynamics between mother and child concerning children's developing cognitive and social functioning. Landry's team confirmed their hypothesis: maternal efforts to maintain children's interests indirectly contributed to 4 ½ year old children's cognitive and social independence by positively impacting the development of social and cognitive skills at age 2 and 3 ½ years. Additionally, the structural equation model indicated that despite the fact that maternal directiveness fostered children's early cognitive and social responsiveness skills, maternal over-involvement (high levels of directiveness) towards 3 ½ year-old children, led to decrements of cognitive and social independence by 4 ½ years. Whereas, high levels of maternal effort to maintain children's interests across these ages, support the development of independent functioning. To foster cognitive and social independence, maternal directiveness should decrease in relation to children's increasing competencies.

Understanding the mechanism by which children assimilate and develop emotional control strategies is critical. The strategies employed by parents or other adult care providers in regulating their own emotions, and reacting to their children's displays of negative emotion provide the groundwork for children's developing ability to regulate and control the duration, intensity, and valence of their own emotional experience (Eisenburg, Fabes, Shepard, Guthrie, Murphy, & Reiser, 1999; Landry, et. al. 2000; Landry, et. al. 2002; Lefreniere, 2000; Vygotsky, 1978).

Guided self-regulation in the preschool years yields to increasingly internalized coping and control strategies for dealing with emotionally intense situations. Coping mechanisms such as, restricting sensory input (covering eyes and ears), engaging in self talk, and reformulating goals help avoid negative emotional experiences; negative experiences that could overwhelm their fledgling self control mechanisms (Lefreniere, 2000; Thompson, 1994). Pre-school aged children begin to monitor their own behavior, and inhibit responses that they deem inappropriate (Carlson, 2003; Kopp, 1982; Kopp, Krakow, & Vaughn, 1983; Luria, 1980; Zelazo, Mueller, Frye, & Marcovitch, 2003). Concurrent with the development of self-control are declines in instrumental aggression, and increases in pro-social interactions with peers and care-providers.

Progress through each of the development stages outlined by Sroufe (1996) depend upon biological, behavioral, maturational and socialization forces. The capacities developed at each stage are critical and foundational bricolage upon which subsequent developmental stages are built. Early disruption of the socialization (attachment) process is deleterious to resolution at later stages and the formation of adaptive of emotional control and regulation. “Individuals who have effective regulatory skills are more likely to be able to modulate their emotional responsiveness and to act competently and effectively in emotionally evocative contexts” (Fabes et al., 1999, p. 432). Children who have developed effective regulatory mechanisms are better able to exercise self-control, focused attention, inhibit their undesirable responses and control their impulsive urges.

Cognitive and Developmental Neuropsychological

Antecedents of Effortful Control

The last ten years of developmental neuroscience and neuropsychological research has yielded a tremendous increase in understanding the social and environmental mechanisms conducive to optimal neural development in the first three years of life. This research supports many of Bowlby's earliest hypotheses (1969), including his contention that biological, social, and emotional developmental processes are the products of an interactional transaction between an individual's unique genetic endowment, and the environmental conditions into which the infant is born and reared. Critical to optimal maturation of the child is the quality of the primary care provider's regulation of the infant's environment (Schor, 2001a).

Strong and secure attachment relationships are associated with positive developmental outcomes. For example, toddlers who have enjoyed secure infant attachment histories are more likely to demonstrate greater than average persistence and problem-solving skills, heightened levels of positive affect, and enthusiasm (Matas et al., 1978) and improved attention span (Maslin-Cole & Spieker, 1990). Preschoolers benefiting from secure infant attachment histories show increased flexibility, persistence, and resourcefulness (Arend, Gove, & Sroufe, 1979). Six-year-olds with secure infant attachment histories manifest increased cognitive inhibition and control over impulses, improved ability to delay gratification, and improved task orientation (focused attention) (Jacobsen, Huss, Fendrich, Kruesi, & Ziegenhain, 1997; Olson et al., 1990).

Bowlby's original conception of attachment theory as an interdisciplinary science has been borne out by recent advances in affective neuroscience. These developmental

neurobiological explanations of the consequences of relational trauma or other environmental stress regarding the development of EC processes are complex. This complexity concerns: 1) an appreciation of the three types of neural processes by which brain development is affected, 2) identifying the neural structures, networks, and systems involved in the development of EC, 3) understanding the maturational processes of those neural structures, networks, and systems, under optimal conditions and 4) exploring the three mechanisms through/by which experience impacts the maturation of neural development.

Three Kinds of Neural Developmental Processes

Black, Jones, Nelson and Greenough (1998) identified three kinds of neural developmental processes: 1) gene-driven, 2) experience expectant, and 3) experience dependent. *Gene-driven* neural developmental processes are protected from, and are relatively impervious to experiential influences. In this way the most fundamental elements of neural development are sheltered from potentially threatening environmental circumstances. Operations such as the migration of neurons and the formation of the deepest central neural structures are gene-driven (Black, Jones, Nelson & Greenough 1999; Cicchetti, 2002).

Experience expectant maturational processes refer to developmental critical periods (usually an early age-locked sensory system developmental period) when specific environmental stimulation is required to differentially activate particular neural circuitry so that nearby, but irrelevant or redundant neural connections can be eliminated and synaptic networks most salient to experience can be selectively maintained and

strengthened (Black et al., 1999; Cicchetti, 2002). Neural pruning is the central mechanism responsible for this process.

The notion of *experience dependent* maturation posits that critical brain structures, as well as the neural circuitry connecting and comprising the hierarchical relationships necessary for effective self-regulation are formed by the nature of the infant's experiences. "Experiences that facilitate the brain growth spurt in the first year of human life are embedded in the affect transacting relationship co-constructed by the infant and primary caregiver" (Schorer, 2001a, p. 2). Schorer (2001a) argues that these *experience dependent* maturational processes underscore the value of a secure primary attachment relationship to neural developmental processes. In essence his position is that the first 36 months of life are a critical period of postnatal development. During this time the human control center is custom designed and developed. The kinds of environmental opportunities and relational experiences to which a young child is exposed dictates the extent and shape of the neural structures and the relationships among those structures. The developmental timing of this critical postnatal period is no accident. The brain's ability to form itself in response to environmental conditions serves an important evolutionary adaptive function. Experience dependent maturation guarantees that "the early social environment directly impacts... maturation of the limbic system, the brain areas specialized in the organization of new learning and the capacity to adapt to a rapidly changing environment" (Schorer, 2001b, p. 16). The clear implication of the notion that environmental and social factors impact the developing brain systems responsible for the regulation and processing of emotion is that interpersonal relationships "directly influence the ontogeny of the biological brain systems that mediate

the future adaptive and maladaptive coping capacities of the individual” (Schore, 2001a, p. 3).

The downside of this generally adaptive trait is that in some unfortunate circumstances such as child neglect, relational trauma, or insecure attachment, the amount of environmental exposure to situations conducive to brain development is inadequate. When opportunities for the development of brain structures that foster normal functioning are lacking, pathology or less than optimal functioning results (Gerhardt, 2004; Schore, 2001c).

A central feature of experience dependent development is the creation, maintenance, and strengthening of new neural pathways and circuits to allow the organism to appropriately and adaptively respond to an ever changing environment (Black et al., 1999; Cicchetti, 2002; Schore, 2001a).

Comprehensive descriptions of the neural developmental processes responsible for experience dependent maturation are beyond the scope of this paper. However, simplified descriptions of these processes will be offered to communicate what occurs in the first three years of a child’s neural development. How neglect, abuse, or any relational traumata negatively impacts early brain growth will also be addressed.

Neural Structures

The right hemisphere is dominant during the first three years of life. The first three years of life constitute a critical period for experience dependent maturation of right brain neural structures. These right hemisphere neural structures, networks, and systems are responsible for processing the physiological and cognitive workings of social/emotional information (Schore, 2001a) and regulating the human stress response. Infants who

experience a well-regulated and appropriately controlled environment will develop, through the process of experience dependent maturation, those right hemisphere neural structures, networks, and systems that facilitate self-regulation and EC of emotional and cognitive processes (Bell & Wolfe, 2004; Cole, Martin, & Dennis, 2004; Fox, 1994; Gerhardt, 2004; Lupien & McEwen, 1997; Mendl, 1999; Schore, 2001b; Spangler & Grossman, 1993).

Research regarding the specific neural structures, networks, and systems involved in the development of EC indicate the central role of the orbitofrontal cortex and anterior cingulate cortex in regulating the right hemisphere sub-cortical limbic structures including the hypothalamus, and the amygdala (Davis et al., 2002; Schore, 2001b). These neural structures and networks link effortfully controlled behavior to the executive attention system (Posner & Rothbart, 1998). Neuropsychological research into the biological basis of attention and executive function has identified distinct and separable neural networks, which together function to maintain alertness, orientation to sensation, and volitional control of thoughts and emotions (Posner & Rothbart, 1998). The prefrontal cortex, anterior cingulate, and basal ganglia are currently thought to be the areas involved in these executive function networks (Rothbart et al., 2003).

Specifically critical to the construct of EC is the executive function of “conflict resolution.” Increasing amounts of evidence are implicating the anterior cingulate and the orbitofrontal area of the prefrontal cortex as central to this executive ability of conflict resolution (Botvinick, Braver, Barch, Carter, & Cohen, 2001). This prefrontal executive network is responsible for monitoring and resolving conflicts among the various neural structures in charge of specific operations and responses (Botvinick et al., 2001).

Children's developing abilities to exercise effortful or volitional control and resolve conflict among competing cognitive and emotional demands must be directly linked to the development of this prefrontal executive network. The successful formation of these executive networks will foster the capability to exercise self-regulation and EC (Rothbart et al., 2003).

Neuroscience researchers are examining the networks linking the cortex to the limbic system so as to better understand the process of effortful emotional control.

In current neuroscience, the neuroanatomy of the limbic system is characterized as a hierarchical system of vertically organized circuits within the brain. And so authors are now referring to the “rostral limbic system” a hierarchical sequence of interconnected limbic areas in orbitofrontal, insular cortex, anterior cingulate, and amygdala (Devinsky, Morrell, & Vogt, 1995), an “anterior limbic system” composed of orbitofrontal cortex, basal forebrain, amygdala, and hypothalamus (Schnider & Ptak, 1999), a “paralimbic circuit” containing orbitofrontal, insular, and temporopolar cortices (Mesulam & Mufson, 1982), an “anterior limbic prefrontal network” interconnecting the orbital and medial prefrontal cortex with the temporal pole, cingulate, and amygdala (Carmichael & Price, 1995), and a complex circuit of emotion regulation consisting of orbital frontal cortex, anterior cingulate, and amygdala (Davidson, Putnam, & Larson, 2000). (Schorre, 2001b, p. 29)

In circumstances of optimal social and emotional development, reciprocal relationships exist among the neural structures that comprise these corticolimbic systems.

It is through these bidirectional circuits that information can be shared up and down the limbic axis for comprehensive assessment and hierarchical modulation (Schore, 2001b) that result in EC process related to attentional control, control over impulsive responding, and emotional regulation.

Maturational Processes

The brain is hierarchically organized and develops its lowest and most primitive neural structures first. These primitive neural structures exist at the center of the brain and are intact and fully functional at birth. For example, the amygdala, which is perhaps the most primitive of the limbic regulatory structures, is fully functional at birth and has an established bidirectional circuit with the hypothalamus. Whereas, the orbital frontal cortex, the most complex structure for regulating emotion, cognition, and behavior does not begin to develop until the end of the first year of life.

The brain is clearly the most dynamic and malleable of the human body's organs during the first year of life. This statement is particularly true in regard to the development of the neural circuitry comprising the limbic system. "These systems are organized from the simplest to the most complex, and they onset in a fixed progression over the first year, with the later maturing hierarchical cortical structures adaptively regulating the earlier maturing subcortical systems" (Schore, 2001b, p. 27).

The orbitofrontal cortex and the anterior cingulate cortex are brain structures highly subject to the effects of experience dependent maturation. These neural structures maintain linkages to the hypothalamus, and each employs parasympathetic and sympathetic regulation strategies. The orbital frontal cortex plays a critical role in impulse control, as well as managing attentional perseverance, regulation, and

maintenance of set and of ongoing behavior. Damage to this prefrontal region of the cortex can result in disinhibitions and impulsivity, (e.g., aggressive outbursts and sexual promiscuity) (Lezak, 1995; Iverson & Dunnett, 1990).

The orbital frontal cortex maintains the highest position in the hierarchy of control of right brain functions. The anterior cingulate cortex also plays an important role. The anterior cingulate cortex “has two major subdivisions to separately process cognitive and emotional information. The cognitive subdivision has interconnections with the prefrontal cortex, parietal cortex, and premotor and supplementary motor areas” (Bell, & Wolfe, 2004, p. 366). An important duty of this subdivision of the anterior cingulate cortex is to regulate responses to tasks requiring conflict resolution such as inhibition tasks and many working memory tasks (Bell, & Wolfe, 2004; Botvinick et al., 2001). “The affective subdivision has interconnections with the orbitofrontal cortex, amygdala, and hippocampus among other brain areas, this subdivision is activated by affect related tasks” (Bell, & Wolfe, 2004, p. 366).

Experience and Neural Development

Social experience impacts the development of neural structures and circuits in three separate ways. Two of the three mechanisms by which experience impacts neural development are biochemical. Sympathetic arousal triggers the release of particular endogenous opioids which help neurons grow by regulating glucose and insulin. Parasympathetic reactions to stressful or traumatic events trigger the production of the stress hormone cortisol. The third mechanism impacting brain maturation occurs through the process of neural pruning.

Biochemical sympathetic response.

Positive affective interaction between a primary care provider and her infant has been identified by Schore (2001b) as the most vital stimulus for growth “of the social, emotionally intelligent brain” (Gerhardt, 2004, p.41). Pleasurable and appropriately regulated interactions with the primary care provider arouse the sympathetic nervous system, and result in the simultaneous release of dopamine and specific endogenous opioids (neuropeptides) like beta-endorphin in the orbitofrontal cortex. These opioids cause a pleasurable sensation. They facilitate the development of the neural structures at the synapse by regulating the release of glucose and insulin (Gerhardt, 2004; Schore, 2001b). The neurotransmitter dopamine is sent from the brainstem into the prefrontal cortex. Dopamine produces pleasure and an energizing feeling. Dopamine facilitates the uptake of glucose which contributes to tissue growth in the frontal cortex (Gerhardt, 2004; Schore, 2001b). Through the release of dopamine and endogenous opioids, pleasurable affective interaction stimulates neural growth in the frontal cortex, hippocampus, temporal cortex, and the prefrontal and anterior cingulate. These neural structures, and the circuitry responsible for forming the networks between them, rely upon experience dependent maturation to reach an optimal level of functioning.

Biochemical parasympathetic response.

Negative, stressful, or overwhelming affective experiences cause a parasympathetic biochemical reaction. Parasympathetic stress response involves a biochemical communication from the hypothalamus, to the pituitary gland, ending at the adrenal gland with the production of the stress hormone cortisol. The hypothalamus pituitary adrenal (HPA) axis or stress response (Gerhardt, 2004; Schore, 2001b) axis controls the release

of the stress hormone cortisol. Cortisol, when released in moderation is essential to facilitate the growth of norepinephrine connections from the medulla up to the prefrontal cortex. Norepinephrine helps the toddler's orbitofrontal cortex mature. Norepinephrine increases blood flow to the orbitofrontal cortex and forms links (via the hypothalamus) to the parasympathetic nervous system. The parasympathetic nervous system is vital to the growing child. The child's ability to inhibit responses is contingent upon a well-functioning parasympathetic neural system. This inhibitory system enables the child to control their behavior and respond appropriately to danger (Gerhardt, 2004).

Cortisol counters the effects of endorphins and dopamine. Cortisol negates not only the pleasure response produced by endorphins and dopamine, but also the beneficial effects on neural growth and development (Gerhardt, 2004; Goodyer, Park, Netherton, Herbert, 2001; Schore, 2001c). Chronic exposure to negative experiences such as child neglect, relational trauma, or insecure attachment to a primary care-provider, have been repeatedly demonstrated to result in the overproduction of cortisol (Gunnar et al., 1996; Gunnar & Nelson, 1994; Spangler & Grossman, 1993). Overproduction of cortisol has been linked to decrements to EC process related to emotional control (Fox, 1994a, 1994b), attentional processes (Lupien & McEwen, 1997; Mendl, 1999), cognitive processes including learning and memory (Bell & Wolfe, 2004; Cole, Martin, & Dennis, 2004) and control of inhibition and impulsivity (Gerhardt, 2004; Lyons et al., 2000; Schore, 2001a). Decrements in neuropsychological function result from a variety of neurobiological consequences of high cortisol levels. These deficiencies include: over-activation of the right frontal hemisphere, damage to the hippocampus, and decreasing levels of dopamine and serotonin in the prefrontal cortex. Falling levels of dopamine and

serotonin in the prefrontal cortex can lead to neural degeneration in the anterior cingulate and frontal cortex (Goodyer, Park, Netherton, & Herbert, 2001). Finally, over-production of cortisol can create a cycle of amygdala excitation that results in norepinephrine release. This release of norepinephrine triggers the production of more cortisol (Gerhardt, 2004; Schore, 2001c). Over-exposure to stressful or traumatic environments in early childhood creates a neural proclivity for stress responses. The implication of which is a tendency to form a negative attributive bias to social situations leading to increased numbers of stressful reactions. In short, stressful reactions beget stressful reactions (Goodyer et al., 2001).

Neural pruning.

At birth, the human brain has an overabundance of neural connections. In essence, the early brain is inefficient because of its lack of differentiation. During the first year of life, neural development involves processes by which frequently occurring or repetitive experiences create the development of efficient neural routes or circuits. These well-traveled pathways between and among neurons become established as the architecture of the brain. Dormant or unused connections are pruned away (Black et al, 1999; Gerhardt, 2004). The brain's neural architecture is organized on the basis of the *use it or lose it* principal.

The formation of well-trodden neural circuits into established pathways enables the infant to organize life experiences and make interactions more predictable. Neural pruning facilitates increasingly efficient thinking. Pruning of unutilized or underutilized neural connections has implications in terms of experience dependent maturation. The neglected infant suffering a chronic lack of positive social interaction does not enjoy

sufficient postnatal opportunities to form links between the prefrontal cortex and the amygdala. Without appropriate stimulation these critical connections may be pruned away. Repetitive social and affective interaction fosters the utilization of neural connections which are responsible for processing emotional experiences. Conversely, the absence of social and affective interaction fails to stimulate connections responsible for processing emotional experiences. Thus those circuits are subject to pruning (Gerhardt, 2004; Schore, 2001c). The consequences of deficient neural architecture are dire. Without the neural circuitry connecting the orbitofrontal cortex and anterior cingulate cortex to the sub-cortical limbic structures including the hypothalamus, and the amygdala, no mechanism exists by which the limbic system can be regulated. Individuals suffering such neural deficiencies are prone to anxieties and fears, and can not effectively self-regulate their emotional states.

Current Research

Despite the science indicating how relational stress could interfere with the developmental process involved in the formation of EC capacities and the evidence supporting the critical role played by emotional, social, cognitive, and neuropsychological mechanisms in forming a child's growing brain, insufficient data has been found to confirm that insecure maternal attachment will predict decrements to EC. No research has been conducted seeking to establish a predictive relationship between attachment insecurity and EC (Clarke et al., 2002). The association between insecure attachment, and the development of ADHD was explored by Clarke et al., (2002). Her team's findings are salient to the question, because the construct of EC so closely mirrors

the symptoms of ADHD. The symptoms of ADHD include deficiencies in impulse control, inhibition, initiative, perseverance and emotional regulation.

Indeed, ADHD may be best conceptualized as a disorder of self-regulation, involving a generalized difficulty in integrating cognitive affective and motor functions in response to varying situational demands (Barkeley, 1997; Olson, 1996; Teeter, 1998). It has been suggested that the impairments in self-regulation seen in children with ADHD may have its roots in strained early caregiver-child interactions and disrupted primary attachments (Olson, 1996; Sandberg, 1996; Stiefel, 1997). (Clarke et al., 2002, p. 181)

Clarke et. al., (2002) compared the quality of attachment representations generated by a group of nineteen, five- to ten-year-old boys diagnosed with ADHD to the quality of attachment representations generated by a group of nineteen boys of the same age without psychiatric diagnosis (normal controls). Her team gathered representational models of attachment and the self, using three separate measures including, “the Separation Anxiety Test (Hansberg, 1972), which assesses children's verbal responses to hypothetical separations; the Self Interview (Cassidy, 1988), which assesses children's verbal description of themselves in relation to significant others; and attachment-based ratings of Family Drawings (Fury, Carlson, & Sroufe, 1997), which provide a nonverbal assessment of attachment relationships” (Clarke et al., 2002, p.183). Clarke et al., (2002) hypothesized that the representations of attachment relationships and of the self, generated by the children diagnosed with ADHD, would indicate greater insecurity of attachment than those representations produced by children in the control group.

Statistical analysis confirmed the hypothesized relationship between attachment representations and ADHD. Comparison of the control group's attachment measures to the ADHD group's attachment measures revealed significant differences between the groups. The ADHD group generated poorer scores than the controls on all three sets of measures.

Despite the strength of this study in associating ADHD with attachment security, it failed to offer longitudinal or predictive indications. Several research teams have examined the construct of attachment in terms of secure attachment as a mediator of adaptive functioning. Granot and Mayseless (2001) studied the coexisting relationship between a strong parental bond (security of attachment) and adaptive functioning (psychological adjustment). They studied 113 fourth and fifth grade children, and found that a strong correlation exists between attachment security and children's adjustment to school. As expected, children rated as securely attached demonstrated better adjustment to school as reflected in teachers' reports of scholastic, emotional, social, and behavioral adjustment, as well as in peer-rated social status. Not surprisingly, children rated as less well-attached, specifically, those children whose attachment was rated as avoidant, and children whose attachment was rated as disorganized, showed the poorest emotional adjustment.

Pasco-Fearon & Belsky (2004) conducted longitudinal research investigating the interrelation of attachment security and attentional performance. They included two well-established risk factors for poor attentional performance: male gender and social contextual adversity. They analyzed data from 918 children from the National Institute of Child Health and Human Development (NICHD) Study of Early Childcare. The security

of the attachment relationship to primary care-provider was established using the “Strange Situation” procedure at 15 months of age and attentional performance was evaluated by a Continuous Performance Test and maternal questionnaire at 54 months of age. Social contextual adversity was assessed using a variety of measures at numerous time intervals. Theoretically, Pasco-Fearon & Belsky conceived of secure attachment as a mediator/protective factor guarding against the risks associated with being male and contending with social contextual adversity. They hypothesized, “(a) that individual differences in attachment security are associated with variations in attentional performance and related behavior and (b) that secure attachment would protect children from risk associated with being male and growing up under less support of contextual conditions”(p. 1688). Results indicated that four (4) ½ year-olds with secure attachment histories would be protected from anticipated risks to attentional performance associated with being male and growing up under conditions of high contextual risks. It is of interest to note, in terms of maternal report of attention related behavior, no significant difference emerged, based on attachment classification.

In light of the evidence indicating decrements to EC in children reared in abusive, neglectful, or insecurely attached circumstances, and the lack of research directed towards establishing longitudinal evidence of a relationship between insecure attachment and decrements to EC, this study will directly examine the power of disruptions to early childhood attachment upon the development of children's EC employing a longitudinal data set. The purpose of the study is to discover if securely attached children differ from insecurely attached children in regard to their subsequent formation of EC processes after controlling for the effects of social contextual adversity.

CHAPTER III

METHODOLOGY

This paper seeks to better understand the association between children's early experiences and ensuing developmental outcomes by exploring the connection between the maternal attachment relationship and subsequent formation of the child's executive control system. Specifically, this study aims to discover if securely attached children differ from children who manifest insecure attachment behavior in regard to their subsequent formation of EC processes related to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity. To that end, a select dataset from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care (SECC) database will be analyzed.

Participants

To date, the NICHD SECC has aggregated twelve years of their study's data. The NICHD initiated the SECC study in 1989 to investigate the relationship between child care experiences and children's developmental outcomes. The NICHD SECC, in their efforts to generate data applicable to the general population of the United States located data collection centers throughout a diversity of major geographic regions of the country, including urban, suburban, and rural areas. Recruitment criteria guaranteed the inclusion of a diversity of ethnic groups, family constellations, level of education attainment, and families of a range of socioeconomic status at every site. The scope of the study was large enough to generate sufficient power for complex multivariate analysis of longitudinal data. The study is designed so that children were followed from birth and subjected to a wide array of observational and performance measures including

“extensive direct observation of home, child care, and school experiences...and multiple measures of social-emotional development, cognitive and language development, achievement, and physical growth and health” (NICHD, 2001, p. 461). By studying representatives from diverse populations results will better generalize and assessment of developmental outcomes can be ascertained.

The NICHD employed a research team located at universities (University of Washington, University of California (Irvine), University of Kansas, University of Wisconsin, University of Arkansas (Little Rock), University of Pittsburgh, Western Carolina Center, University of Virginia, Temple University, Wellesley College) across the United States (U.S.) and at the NICHD, this research team selected ten data collection sites and each site recruited participants from area hospitals. The sites were selected to represent a “diversity of geographic regions economic backgrounds, and ethnic groups, with diverse plans for maternal employment during the child's first year of life” (NICHD, 2001, p. 461). In all, 31 hospitals were selected for recruitment of participants. Those hospitals were located in or near Little Rock, Arkansas; Irvine, California; Lawrence, Kansas; Boston, Massachusetts; Philadelphia, Pennsylvania; Pittsburgh, Pennsylvania; Charlottesville, Virginia; Morganton, North Carolina; Seattle, Washington; and Madison, Wisconsin.

In 1991 NICHD SECC team members approached 8,986 women during pre-established 24 hour sampling periods who were admitted to the hospital to give birth regarding their willingness to become involved as participant families with the NICHD SECC. Of the women interviewed 5,416 conformed to the study's eligibility criteria and consented to have further contact with study personnel after their return from the hospital.

To guarantee participating families adequately reflected the desired demographic diversity (socioeconomic, ethnic, and educational) of each catchment area a conditional-random sampling plan was designed and implemented to generate a subset of the original 5,416 women who conformed to the study's eligibility criteria and consented to have further contact with study. One month after childbirth 1,364 families with healthy newborns were enrolled in the study (58% of the conditional-random sample) with approximately equal numbers of families recruited from each site.

It is anticipated that a subset of the total 1,364 participating families will be reported in this study because of missing data on attentional performance at 54 months and fourth grade. Additionally, it is likely that attachment data from 36 months of age in some cases will be either deemed uncodable, or that the Strange Situation procedure was not conducted. The number of participants and their demographic data to be included in this analysis is reported in the results section.

Measures

Families were officially enrolled in the NICHD SECC study during an enrollment visit, which occurred one month after childbirth in the family's home. This home visit included the gathering of demographic data by trained study personnel conducting sections 1 and 2 of the one-month interview (for a detailed description of this interview, the associated variables, and the administration manual contact the NICHD at <http://secc.rti.org>). Security of the child-mother attachment was assessed at 36 months by a modified version of Ainsworth's Strange Situation procedure (a detailed description of this procedure, the associated variables, and the administration manual can be obtained by contacting the NICHD at <http://secc.rti.org>). The preschool Strange Situation

developed by the MacArthur Working Group on Attachment (MacArthur, Cassidy & Marvin and the MacArthur Working Group on Attachment, 1992) is performed during a laboratory visit. Cumulative social contextual risk was assessed via an index comprised of maternal responses to seven measures. Each of these measures and the established risk threshold levels are described in detail below. Measures of observed EC related to attentional control, impulsivity, and emotional regulation were gathered via maternal report using the attention problems subscale of the Child Behavior Checklist (CBCL) (Achenbach, 1991). This study has elected to examine data collected when subjects were between one and 36 months of age, 54 months old and again when subjects were in the fourth grade (generally eleven-years-old).

Performance measures of effortful controlled behavior related to attentional control, and impulsivity were gathered via a Continuous Performance Task (CPT) administered in the laboratory at 54 months and again when subjects were in the fourth grade (generally eleven-years-old). To obtain a detailed description of this procedure, the associated variables, and the administration manual contact the NICHD at <http://secc.rti.org>.

The Strange Situation Procedure

The quality of the young child's attachment bond to a care provider or parent is often discussed in terms of the security of the bond. As a part of her 1963 longitudinal observation of mothers and infants in Baltimore, Mary Ainsworth developed a procedure called "The Strange Situation" specifically to examine similarities and differences between middle class American babies and the babies she had observed in Uganda in regard to the infants' utilization of their care provider as a secure base. Ainsworth was inspired to create the Strange Situation experiment by the 1943 paper "Young Children in

an Insecure Situation” by Jean Arsenian. “The Strange Situation consists of eight episodes presented in a standard order for all subjects, with those expected to be least stressful occurring first”(Ainsworth, Blehar, Waters, & Wall, 1978, p. 32). The entire experiment can be conducted in less than an hour; each episode lasts 3 minutes or less. Video recording of the parent child interaction is necessary so that the interactions may be reviewed and evaluated (Ainsworth & Wittig, 1969, Ainsworth et al., 1978, Brisch, 1999).

An area of developing interest includes the assessment of the attachment security of preschool children using the “Strange Situation” procedure. Several studies have explored the validity of the preschool Strange Situation classifications developed by the MacArthur Working Group on Attachment (MacArthur, Cassidy & Marvin and the MacArthur Working Group on Attachment, 1992) when applied to preschool populations.

The MacArthur coding system classifies preschoolers as secure (B) or insecure (A, C, and D). Secure (B) children are able to resolve the stress of the separation and resume calm, comfortable interaction with the parent. Insecure-avoidant (A) children maintain extreme neutrality toward the parent, and even after reunion rarely express either positive or negative emotion toward the parent. Insecure-ambivalent (C) children show fussy, helpless, whiny, and/or resistant behavior toward the parent. They may seek contact, but find it unsatisfactory. Insecure-controlling/insecure-other (D) children are either controlling or show combinations of strategies, such as avoidance and ambivalence, or avoidance and controlling behavior, during the reunions. Controlling children take

charge of the reunion, usually in either a caregiving (role-reversal) or punitive manner. A child showing more than one type of controlling behavior is classified as controlling-general. Coders also make a global 9-point security rating, in which 1 = Very insecure, 3 = Insecure, 5 = Probably secure, 7 = Secure, and 9 = Very secure. (NICHD, 1999 p. 189).

Several studies examining preschool Strange Situation classifications were conducted drawing upon convenience samples of typically functioning low risk preschool populations (Cassidy, Berlin, & Belsky, 1991; Greenberg & Slough, 1991; Stevenson-Hinde & Shouldice, 1992) and in some cases convenience samples of high risk low income minority preschool populations (Barnett, Kidwell, & Ho Leung, 1998). Additionally, several studies have conducted their analyses comparing high risk groups to typical populations (Booth, Rose-Krasnor, McKinnon, & Rubin, 1994; Cicchetti & Barnett, 1991). These studies produced results consistent with theoretically derived hypotheses lending credence to the validity of the MacArthur coding system. Preschool attachment classification is correlated with the evaluated children's behavioral outcomes and maternal behavior. Booth et al. (1994) examined the predictive validity of preschool attachment classification by examining a heterogeneous sample of 79 children. They studied children's social adjustment outcomes with a longitudinal design. They found "attachment security at age four was the strongest predictor of internalizing problems and social engagement/acceptance at age eight" (Booth et al., 1994 p. 189) and maternal parenting style was the best predictor of externalizing behavioral difficulties. Another example of a study illustrating the validity of preschool attachment classification was conducted by Demulder and Radke-Yarrow (1991). They tracked and compared a sample

of clinically depressed mothers and control mothers, 112 mother child dyads in all. Results indicate secure preschoolers' mothers demonstrated relatively more displays of affection and more neutral-pleasant affect as compared to mothers of insecure preschoolers. Additionally, secure preschoolers' mothers demonstrated less downcast affect, compared with mothers of insecure preschoolers. Another indication of the validity of the Strange Situation classifications developed by the MacArthur Working Group on Attachment Assessment is provided by Barnett et al. (1998). Their study of a sample of 69 four to five-year-old urban, economically disadvantaged, African-American families indicated that the parents of preschool children rated as securely attached evidenced comparatively more warm and accepting behavior than did the parents of insecurely attached children. Parents of insecurely attached children demonstrated a relatively greater number of instances of controlling behaviors, and were more likely to employ physical (corporal) punishments, as well as offering fewer verbal corrections than did parents of securely attached children.

“In the infant and preschool in age groups, attachment is typically assessed using the well validated strange situation procedure, which involves behavioral observations and children's responses to separations and reunions with their caregiver” (Ainsworth et al., 1978). Reunion behavior in particular is thought to be a reflection of children's internal working models of the attachment relationship (Clarke et al. 2002).

The experiment is to be conducted in a “play room” with only one door and a one-way observation mirror through which the proceedings can be video recorded. The room is to be cheerfully decorated, populated with a variety of attractive and age appropriate toys, the mother-child dyad upon entering the room are instructed to “make themselves

comfortable” (NICHD, 1999, p. 189). The room was arranged to contain “a basket of toys, a beanbag chair, a chair for the mother, and a schoolhouse with small plastic figures” (NICHD, p. 189, 1999).

In a typical eight episode Strange Situation procedure each episode is presented in a standard order with the least stressful episode occurring first. Standard Strange Situation procedure follows the following order. During the first and second episode mother and child enter the playroom. Mother has been instructed to encourage her child to independently explore the unfamiliar and attractive toys. Mother is encouraged to refrain from engaging in mutual play and instead to sit in her chair and observe her child’s play or read while her child plays. In the third episode the stranger enters the room. The stranger is a young female who is at first silent. After a minute the stranger begins chatting with mother. The stranger’s presence is expected to provoke a slight curiosity or anxiety in the child who will often respond by moving to increase proximity to mother or becoming more inhibited in his play. During the final minute of the third episode the stranger attempts to make contact with the child and join him in play.

The fourth episode begins when mother responds to a subtle signal from the research team by removing herself from the room without saying goodbye to her child. It is expected that the child will respond to this separation with some distress. The stranger is instructed to try to comfort or divert the child with play. This episode is terminated if the child is inconsolable. The fifth episode begins with the mother calling out the child’s name and then reentering the playroom. Mother is instructed to console her child. Once his distress has abated he is encouraged to recommence independent play. The stranger quietly leaves the room after the mother returns. The sixth episode begins after a 3 minute

respite by mother again responding to a signal from the research team by standing up and saying “bye-bye, I’ll be back.” Mother then leaves the room, this time the child is left completely alone. A stronger expression of discontent and distress is anticipated than the reaction to the first separation. The seventh episode begins after 3 minutes or earlier if the child is felt to be too distressed with the stranger returning to the playroom. The stranger is instructed to attempt to calm or distract the child with play. If the stranger’s efforts to console the child fail or after a 3 minute period the mother returns. Mother is directed to offer comfort and consolation to her child as needed and then gently encourage continued independent play (Ainsworth et al., 1978, Brisch, 1999).

Ainsworth noted that children’s reaction to these episodes, particularly reunion behavior, varied based on the strength of the child’s bond to the attachment figure (Ainsworth et al., 1978; Brisch, 1999). The strange situation experiment generated observational data to support the creation of a system for describing the quality of the infant’s attachment bond to its primary care provider.

The NICHD SECC employed a modified Strange Situation procedure to assess attachment security at 36 months. They designed and implemented the 36 month Strange Situation procedure based on recommendations generated by Cassidy and Marvin and the MacArthur Working Group on Attachment (1992). The modified procedure was designed to be moderately stressful for the child. The modified Strange Situation procedure is videotaped. A comprehensive description of the modified procedure and a discussion of the scoring strategies are here presented as excerpted from the NICHD Study of Early Child Care: Phase I Instrument Document:

After three minutes the mother was signaled to leave. The first separation

lasted 3 minutes, unless the child was distressed. After a 3-minute reunion, the mother left again, and the second separation lasted for 5 minutes, unless the child was distressed, in which case the mother returned to the room early. The assessment was terminated after 3 minutes of the second reunion. Research assistants at the 10 sites were trained and certified to conduct this modified Strange Situation according to standard procedures. (NICHD, 1999 p. 189)

Every administration of the Strange Situation procedure was videotaped and independently reviewed by a coder trained in the MacArther coding system. All of the child's behaviors are aggregated and classified according to the MacArther coding system (NICHD, 1999). All coders possessed a minimum of four years experience coding the Strange Situation procedure and received additional training (Pasco-Fearon & Belsky, 2004). Pasco-Fearon and Belsky (2004) found good inter-rater reliability, 83% agreement between all coders ($\kappa = .69$) before conferencing.

For this study's purposes the participating children's attachment classification is divided dichotomously. Subjects were rated as either securely attached or as manifesting insecure maternal attachment behavior. This simplification of the attachment nomenclature was necessary to address the central question posed by this research. The chief purpose of this study is to examine if securely attached children differ from children who manifest insecure maternal attachment behavior in regard to their subsequent formation of EC processes after controlling for the effects of social contextual adversity. As the fundamental question at issue in this research is to determine if differences exist between children evaluated as experiencing a secure maternal attachment relationship and

children who manifest insecure maternal attachment behavior the use of the entire MacArther coding system is unnecessary. Children rated by the MacArther coding system as insecure A, C, and D were coded as insecure. Children found to be secure B were coded as secure. The global 9-point security rating scale was not employed in making the determination of attachment security.

Cumulative Social Contextual Risk

The cumulative social contextual risk index employed in this research is modeled after Pasco-Fearon and Belsky's (2004) cumulative risk variable and the work of Rutter and Quinton (1977) who provided compelling evidence that the aggregate of multiple social contextual adversity factors best predict mental illness and negative outcomes rather than any single psychosocial contextual risk factor. In this vein Pasco-Fearon and Belsky (2004) identified nine measures of risk to represent critical elements of: 1) psychosocial contextual risk (i.e., maternal depression, social support, observed maternal support for cognitive development, and father absence), 2) socioeconomic environment risk (i.e., economic status, maternal age, maternal education and maternal verbal intelligence quotient (IQ)) and 3) child constitution (i.e., child temperament). These nine selected measures were part of the NICHD SECC Phase I data collection. Every subject's cumulative risk index was calculated by aggregating the total number of risk factors which met or exceeded a specified theoretically derived threshold. Subjects who scored above the specified threshold on more than one risk factor were coded by Pasco-Fearon and Belsky (2004) as "high risk" and subjects whose scores were not above the specified threshold at all, or on only one measure, were coded as "low risk" (Pasco-Fearon & Belsky, 2004). This study will employ seven of the nine measures used by Pasco-Fearon

and Belsky (2004) to represent the cumulative social contextual risk index. The two excluded measures include: the variables referred to as “maternal stimulation of cognitive development” and “child temperament.”

Maternal stimulation of cognitive development is not included in this study’s calculation of each subject’s cumulative social contextual risk (this study’s covariate) because the construct of maternal stimulation of cognitive development is thought to share too much variance with the construct of attachment (this study’s independent variable). Child temperament is excluded because temperament is by definition a trait unrelated to the social environmental context of the child (Thomas & Chess, 1977) and this index is designed to establish the cumulative social contextual risk in each child’s life. Additionally, no psychometric data is available to support the modified Infant Temperament Questionnaire (ITQ) employed by the NICHD Study of Early Child Care (NICHD, 1999) to measure care giver ratings of infant temperament.

In addition to employing largely the same set of measures used by Pasco-Fearon and Belsky (2004) to represent the Cumulative Social Contextual Risk Index, the same general formulas used by Pasco-Fearon and Belsky (2004) will be used to calculate risk thresholds for each of the measures. However, rather than treating the cumulative social contextual risk index as a dichotomous variable (high and low risk groups) this research will treat cumulative social contextual risk as a continuous variable. This continuous variable is a weighted risk score. Every subject’s cumulative risk index score was calculated by aggregating the total number of risk factors which met or exceeded the specified theoretically derived threshold, a number between 0 to 7. A multiple regression was then conducted using the raw aggregate value of each risk factor as the predictor

variable and the total number of risk factors which met or exceeded a specified theoretically derived threshold as the criterion variable. The weighted cumulative risk index score was then calculated by finding the sum of each risk factors' raw aggregate value and multiplying it by the unstandardized coefficient B for each risk factor. In this way each subject's weighted cumulative risk index score is presented as continuous variable. The unstandardized coefficient B for each risk factor are presented in the pre-analysis section of the results.

Maternal Age

The risk threshold for maternal age is 18, meaning the subject is at risk (above threshold) if he was born on or before his mother's 19th birthday.

Maternal Education

The maternal education risk threshold is established as no more than high school education achieved by the time of the one month home visit and interview conducted by the NICHD Study of Early Child Care as described in the Phase I Instrument Document of the NICHD Study of Early Child Care (NICHD, 1999). The subject is at-risk (above threshold) if by the one month home visit and interview his mother has no more than a high school education.

Low Maternal Verbal Intelligence

The Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn & Dunn, 1981) was used to estimate maternal verbal IQ when children were 36 months of age. The risk threshold is established as a PPVT-R score of ≤ 80 . The subject is at risk (above threshold) if at the 36 month lab visit, maternal verbal intelligence as estimated by administration of the PPVT-R, falling at or below a standard score of 80.

The PPVT-R is an individually administered clinical instrument requiring only non-verbal responses. The PPVT-R was designed to assess the receptive vocabulary of children and adults aged 2 ½ to 40 years of age. The PPVT-R is comprised of 175 plates each depicting four pictures (one in each quadrant). These plates are arranged to increase in difficulty as the subject progresses through the testing session. Subjects are required to respond to a verbally presented stimulus word by indicating which of each plate's four pictures best represents the word. The test is not timed and typically can be administered in approximately 20 minutes.

Dunn & Dunn (1981) report internal consistency reliability coefficients on Form L ranging from .80 to .83. The reported reliability coefficients are derived from split-half correlation based on all 800 adult subjects in the standardization sample.

The NICHD Study of Early Child Care Research Network (1999) Phase I: Instrument Document references several studies which have explored the concurrent validity of the PPVT-R. These studies include the work of Altepeter & Johnson (1989) who studied a sample of 60, 18- to 48-year-old typical, neurologically intact adults. In their study, Altepeter & Johnson (1989) compared the estimations of cognitive ability derived from the PPVT-R to the Wechsler Adult Intelligence Scale - Revised (WAIS-R). Their work produced the following Pearson correlations: PPVT-R and WAIS-R Full Scale ($r = .47, p < .05$); PPVT-R and WAIS-R Verbal ($r = .52, p < .05$); PPVT-R and WAIS-R Performance ($r = .24, p < .05$). Mangiaracina & Simon (1986) pursued a similar line of inquiry. They compared the estimations of cognitive ability derived from the WAIS-R to PPVT-R scores in a sample of 40, 18- to 40-year-old psychiatric inpatients. Mangiaracina and Simon (1986) computed Pearson correlations between the PPVT-R and WAIS-R Full

Scale scores ($r = .87, p < .001$), the PPVT-R and WAIS-R Verbal scores ($r = .90, p < .001$), and the PPVT-R and WAIS-R Performance scores ($r = .74, p < .001$).

Carvajal, Kixmiller, Knapp, Vitt, & Weaver (1991) compared the PPVT-R performance of 31 20- to 23-year-old upper-division college students to the Pre-Professional Skills Tests (PPST), the WAIS-R, and the Stanford-Binet Intelligence Scale (4th ed.) Their study found the following Pearson correlations: PPVT-R and PPST Reading ($r = .68, p < .001$); PPVT-R and PPST Mathematics ($r = .49, p < .01$); PPVT-R and PPST Writing ($r = .62, p < .001$); PPVT-R and WAIS-R ($r = .47, p < .05$); and PPVT and Binet IV ($r = .59, p < .01$).

Altepeter and Johnson's (1989) work produced Pearson correlations similar to those generated by Carvajal's (1991) research team. Mangiaracina and Simon's (1986) study indicated strikingly greater levels of correlation than those found by Carvajal et al., (1991) or Altepeter and Johnson (1989). A possible explanation of the increased correlation values found by Mangiaracina and Simon (1986) is that their sample of 18- to 40-year-old psychiatric inpatients were consistent in scoring poorly on both the WAIS-R and the PPVT-R. For a detailed description of this procedure, the associated variables, and the administration manual, contact the NICHD at <http://secc.rti.org>.

Economic Status

The *Low Economic Status* (LES) risk is calculated via an income-to-needs ratio assessment at 1, 6, 15, 24, 36, and 54 months of the subject child's age during Phase I of the NICHD Study of Early Child Care. The income-to-needs ratio was calculated at each of these measurement intervals (1, 6, 15, 24, 36, and 54 months) by dividing total family income by a pre-established dollar value poverty threshold set by the U.S. Census Bureau

(U.S. Department of labor, 1994) so that poverty (risk) is defined by the income-to-needs ratio falling at <1 . The poverty threshold employed is based upon U.S. Department of Labor data which accounts for the size of the family unit and number of dependant children under the age of 18. The LES risk threshold in this study is calculated by computing the mean income-to-needs ratio of each aforementioned measurement interval and defined by the income-to-needs ratio falling at <1 . Pasco-Fearon and Belsky (2004) report internal consistency (Cronbach's alpha) of this risk index as .93. Income-to-needs estimations are well documented as correlated with parenting and children's developmental outcomes (NICHD Early Child Care Research Network, 2003; Belsky & Pasco-Fearon, 2002; Biederman et al., 1995; Rutter & Sroufe, 2000). The overall risk threshold is set as a child living below the established poverty level (income-to-needs ratio falling at <1) during four or more of the measurement periods.

Maternal Depression

The Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977) is a self report rating scale developed to easily and quickly aid in the identification and assessment of depression in the general population. The measure is a simple 20 item questionnaire written at the fourth grade level that assesses the frequency and duration of the symptoms associated with depression. The CES-D is one of the most popular and widely used depression scales employed to obtain estimates of the prevalence rates of depression in population surveys (Shafer, 2006) The CES-D was not designed to be used as a diagnostic instrument, it was designed to be used as a screening device. The CES-D provides an efficient mechanism for deriving an estimation of the degree of depressive symptoms an individual is experiencing. Individual's scores are to be considered in

relation to their reference group the provided cut-off scores are insufficient for diagnosis. Many items selected for inclusion as part of the CES-D existed in previously developed depression scales. Administration of the CES-D generates one global score without offering any breakdown of that score or subscales.

The CES-D is scored based upon the subject's total score of a possible 60 points. Respondents indicate the frequency of experiencing the symptoms described by each of the CES-D's 20 items. Zero points are awarded for responses indicating rarely or none of the time or less than one day. One point is awarded for responses indicating some or a little of the time, 1 to 2 days. Two points are awarded for responses indicating occasionally or a moderate amount of the time, 3 to 4 days. Three points are awarded for responses indicating most or all of the time, 5 to 7 days. All items are scored this way except items 4, 8, 12, and 16 which are reverse scored so that a response of all or most of the time is awarded zero points. CES-D scores of 16 to 21 are considered indicative of a mild or moderate clinical depression and scores over 21 indicate the possibility of major clinical depression.

Radloff's (1977) scale was administered to mothers at the 1, 6, 15, 24, 36, and 54 month measurement periods of Phase I of the NICHD Study of Early Child Care. Risk threshold for maternal depression is defined by a score on any two administrations of the CES-D falling at or above 16 points.

Though there are no declared subscales for the CES-D, four areas for depressive symptoms are measured including: positive affect, depressed or negative affect, somatic symptoms, and interpersonal problems. These four factors have been supported by numerous studies (Shafer, 2006).

The CES-D was selected for inclusion in the NICHD SECC because of its wide use in the assessment of depressive symptomatology in non-clinical samples (Roberts & Vernon, 1983; NICHD, 1999). Maternal depression is included in the calculation of cumulative social contextual risk because of the high incidence of postpartum depression in the general population (Gordon, Cardone, Kim, Gordon, & Silver, 2006) and the deleterious outcomes associated with children of depressed mothers (Weissman, Wickramaratne, Nomura, Warner, Pilowsky, & Verdeli, 2006).

Radloff (1977) reports an internal consistency coefficient alpha of .85 in the general population based upon the aggregation of data from subjects' responses to the CES-D in two studies. The first of these studies collected the responses of 2,514 white adults in Kansas City, Missouri, and Washington County, Maryland. The second study collected the responses of 1,060 white adults in Washington County, Maryland (Radloff, 1977). Pasco-Fearon and Belsky (2004) report finding internal consistencies (Cronbach's alphas) ranging from .88 to .91 in their sample. Additionally, Radloff (1977) reports a test-retest reliability coefficient alpha of .90 in clinical populations, based upon the responses of 70 psychiatric inpatients to the CES-D.

The concurrent validity of the CES-D is reported as high by Radloff (1977), Roberts and Vernon (1983), and Orme, Reis, and Herz (1986) based upon finding strong positive correlations between the CES-D and other common measures of depressive symptomatology such as the Beck Depression Inventory (BDI) and the Hamilton Rating Scale for Depression (HRSD).

Support for the construct validity of the CES-D is offered by Shafer's (2006) meta-analysis of the CES-D's factor analytic structure. Shafer meta-analysis of the CES-D's

factor analytic structure was confirmatory of Radloff's (1977) original four factor solution which included: positive affect, depressed or negative affect, somatic symptoms, and interpersonal problems. A sample of this scale is included in Appendix A.

Social Support

The Relationships with Other People (ROP) questionnaire (Marshall & Barnett, 1993) was administered to mothers at the 1, 6, 15, 24, 36, and 54 month measurement periods during Phase I of the NICHD Study of Early Child Care (NICHD, 1999). The ROP questionnaire is an eleven item self report scale. Maternal raters respond to each self descriptive item by endorsing a value along a six-step likert type response scale. A one (1) is selected to indicate an item is true *none of the time*, and a two (2) indicates that the item is true *a little of the time*. A three (3) is selected to indicate the item is true *some of the time*. The scale continues (4) *A good bit of the time*, (5) *Most of the time* and (6) *All of the time*.

Scored maternal responses to the Relationships with Other People questionnaire are included as a part of the cumulative social contextual risk index because maternal impressions of the adequacy of their social support system are thought to be highly correlated with maternal stress and adaptive coping (House, Umberson, & Landis, 1988). Well developed social networks and connections to others help people in general, and such social networks are specifically vital in aiding parents of young children to manage stress and maintain psychological health and well being (Crnic, Greenberg, Ragozin, Robinson, & Basham, 1983). Marshall & Barnett collected normative data for the Relationships with Other People questionnaire from two samples. Sample A included 403 female social workers and licensed practical nurses. The sample was 85% white.

Sample B included 300 males and 300 females and was 97% white. Very high reliability coefficients were established in both samples (Cronbach's alpha is .91 in both sample groups) and test-retest reliability over a four month period was .68 (Marshall & Barnett, 1993). Concurrent validity was established by correlating respondents scores to diagnoses of anxiety ($r = -.23$, $p < .001$), depression ($r = -.38$, $p < .001$), and Physical well being ($r = -.20$, $p < .001$) (Marshall & Barnett, 1993).

Risk threshold for “Social Support” was established as a mean score on any two administrations of the Relationships with Other People questionnaire from the 1, 6, 15, 24, 36, and 54 month measurement periods falling at or below 2.5 points. Mean scores were calculated by dividing the sum of the non-missing items on the Relationship with Others questionnaire by the number of non-missing items. A sample of this scale is included in Appendix B.

Father Absence

A determination of father absence was derived from maternal response to questions concerning the extent of the child's paternal contact over the course of the child's first 36 months of life. During the NICHD Study of Early Child Care's Home Interview at 1, 6, 15, 24, and 36 months data was collected from mothers relating to the extent of the child's paternal contact. Mothers of children who were not cohabiting with their fathers were questioned regarding the extent of children's paternal contact during the 15 month and 36 month, Home Interview. Risk threshold for paternal absence is defined by maternal responses' indicating not only a consistent paternal absence from the child's home living environment over the child's first 36 months of life but also maternal responses' indicating no paternal contact with the child.

Measures of Effortful Control

EC is a construct employed to describe aspects of the executive control system related to attentional control, impulsivity, and emotional regulation. As stated earlier, the construct of EC is uniquely useful because it is meant to refer to emotional, social, and cognitive regulatory function, and combines emotional, cognitive, and behavioral self-regulatory capacities (Davis et al., 2002; Eisenberg & Spinrad, 2004; Posner & Rothbart, 2000). Though EC is a construct developed by Rothbart and her colleagues as part of their work on temperament (Rothbart, 1989; Rothbart, & Ahadi, 1994; Rothbart & Bates, 1998; Rothbart et al., 1994; Rothbart et al., 2003), the utility of conceptualizing emotional, social, and cognitive control processes together as a unitary notion that is salient to developmental outcomes beyond early childhood is unmistakable.

Evidence supports the interdependence between emotional, social, and cognitive functions (Bell & Wolfe, 2004; Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000). A consequence of serious dysfunction in any one of these domains (emotional, social, or cognitive) will most often result in decrements to self-regulatory and executive functioning (Cicchetti, 2002). For this reason the construct of EC is here extended upward to pertain to and describe emotional, social, and cognitive control processes through early adolescence.

This upward extension of Rothbart and Bates (1998) temperament construct will hopefully aid in the quest to develop a better understanding of psychopathology and the developmental pathogeneses of disorders related to attention, executive function and conduct.

Optimal EC function is associated with effective self-regulation, emotional-regulation, adaptability, flexibility, inhibition of response (impulse control), and attentional control (Davis et al., 2002; Murray & Kochanska, 2002; Posner, 1995; Posner & Rothbart, 1998; Rothbart & Bates, 1998). Conversely, diminished EC functioning is associated with poor or ineffective self-regulation, inattention, impulsivity, diminished mental control, hyperactivity, aggression, disorganization, and emotional lability.

Though the construct of EC has several definitions a consensus exists that the construct of EC pertains to the differential activation and deactivation of a range of cognitive and emotional executive control functions (Davis et al., 2002; Posner, 1995; Posner & Rothbart, 1998) including: attentional focusing and control, inhibitory and activational control, response inhibition, planning, mental flexibility, affect regulation, and self-regulation (Davis et al., 2002; Eisenberg & Spinrad, 2004; Posner, 1995; Posner & Rothbart, 1998; Rothbart et al., 1994; Rothbart & Bates, 1998).

The measures selected to represent EC function in this study were selected based primarily upon the work of Posner & Rothbart (2000) and Davis et al., (2002). Posner & Rothbart (2000) derived their definition of EC from a factor analysis of the Children's Behavior Questionnaire (CBQ; Rothbart et al., 1994). Their definition of EC includes attentional focusing and inhibitory control. They also suggest "EC provides the attentional flexibility needed to link negative affect, action outcomes, and moral principles" (p. 435). Davis et al., (2002) built upon the work of Posner and Rothbart (1994) who articulate the contribution and centrality of a neural network labeled by Posner (1995) the anterior attention system. The anterior attention system involves sections of the midprefrontal cortex including the anterior cingulate gyrus (ACC). Davis

et al. (2002) suggest and endeavor to demonstrate that the anterior attention system plays a significant role, not only in the control and modulation of attentional and executive processes related to impulsive behavior, but also that the ACC is central to affective processing. They argue “the ability to effortfully control behavior and attention is related to the reactivity and regulation of stress systems (Dettling, Parker, Lane, Sebanc, & Gunnar, 2000; Gunnar, Tout, de Haan, Pierce, & Stansbury, 1996)” (Davis et al., 2002, p. 45).

Theories promoting this connection between attention, cognition, and emotion are consistent with much of Cohen’s (1993) work identifying types of “neural inhibition.” Cohen’s “unidirectional inhibition” appears to mirror the notion advanced by Davis et al. (2002) of an anterior attention network linking cortical (frontal) and subcortical structures including the HPA system. Unidirectional inhibition, like the concept of EC, pertains to the ability to “control behavior ...maintain arousal and self-monitoring of behavior (self-control)” (Riccio et al., 2002, p. 241). This connection is important because Riccio et al. (2002) suggest that the Continuous Performance Task (CPT) is a measure of unidirectional inhibition.

In this study elements of the construct of EC related to attentional control, impulsivity, and emotional regulation will be measured. Estimations of effortfully controlled behavior related to attentional control, impulsivity, and self-regulation will be derived based upon maternal responses to observational rating scales. Additionally, a performance measure of EC function will be gathered via a CPT.

The Child Behavior Checklist (CBCL) attention problems subscale (Achenbach, 1991) will be employed to standardize maternal observational data.

The CBCL attention problems subscale was selected to serve as a method for deriving observer based estimations of EC because Murray and Kochanska (2002) demonstrated that 4-year-old children evincing poorly developed EC as measured by the “EC behavioral battery” were found to show significant elevations on the CBCL’s Attention Problems Scale.

The CPT was selected as a performance measure of effortful controlled behavior because it provides data indicating attentional control (omission errors) and impulsive, dysinhibited behavior (commission errors) (Epstein et al., 2003). Taken together, omission and commission errors neatly tap Kochanska, & Murray, (2002) factor “Supress/Initate.” Because the Supress/Initate is possibility the most salient EC factor the CPT seems a good fit for this study (Tracy & Brotman, 2003). To provide additional support for the selection of omission and commission as adequately representative of the many scores generated by the CPT a principal component analysis is presented in the results section to identify the principle component structure of the various measures of effortful control.

Child Behavior Checklist

The Achenbach Child Behavior Checklist (CBCL) (Achenbach, 1991) is a rating scale including 118-items created to provide an accurate and reliable indication of children’s behavioral and social competence. Parent raters respond to each item by endorsing a value along a three-step response scale. A zero (0) is selected to indicate an item is *not true*, a one (1) indicates *somewhat or sometimes true*, and a two (2) indicates *very true or often true*. Ratings of child behavior are grouped into two broad-band scales. The Internalizing Scale measures behavioral manifestations of mood states such as,

anxiety and depression, and the Externalizing Scale measures clearly observable disruptive behavior, such as, antisocial acts, uncontrollable hyperactive behavior, and aggressive actions. The CBCL additionally provides a division of the two broad-band scales into narrow-band “syndrome” scales which provide information regarding specific areas of behavioral concern (e.g., withdrawn, somatic, aggression). A strength of the CBCL is that in addition to the two broad-band scales and the narrow-band “syndrome” scales three competency scales are also derived from raters’ responses. These competency scales provide an index of child performance in the areas of: school, activities, and social function.

The CBCL is possibly the most popular and widely used instrument for assessing social competence and behavioral problems of children between the ages of four and 18 years of age (Dole, 2001; Flanagan, & Steuart, 2005.). Literally thousands of studies have been conducted using the CBCL to assess and quantify child behavior (ASEBA, 2006). Many studies have supported its validity and reliability and it is widely regarded as the “gold standard” against which other behavioral rating scales are measured (Achenbach, 1991; ASEBA, 2006; Goodman & Scott, 1999). The CBCL has well established concurrent validity, high test-retest reliability ($r = .97$) (Achenbach, 1991) and has established its utility for detecting ADHD like symptoms (Biederman, Monuteaux, Kendrick, Klein, & Faraone, 2005; Chen, Faraone, Biederman, & Tsuang, 1994). The CBCL was selected to serve as a method for deriving observer based estimations of EC because Murray and Kochanska (2002) demonstrated that 4-year-old children evincing poorly developed EC as measured by the “EC behavioral battery” (ibid.) were found to show significant elevations on the CBCL’s Attention Problems Scale. It is of interest to

note that no association was established between these under controlled 4-year-old children and the CBCL's Externalizing Behavior Scale. Based upon these findings observer based estimations of EC will be generated through an examination of the CBCL's Attention Problems Scale.

Continuous Performance Task

The Continuous Performance Task (CPT) is a computer administered test which requires subjects to respond to a specified (target) visual stimulus by pressing a designated button when the target stimulus appears upon the computer's screen. The CPT is a test of vigilance, sustained attention, attentional control, impulsivity, and response inhibition (Conners, Epstein, Angold, & Klaric, 2003; Epstein et al., 2003; Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991; Riccio et al., 2002). Two versions of the CPT were used in this study, a young children's CPT based upon specifications described by Mirsky and colleagues (Mirsky et al., 1991) was used with children during their 54 month lab visit, and a version modeled after the original CPT developed by Rosvold and Mirsky (Rosvold, Mirsky, Sarason, Bronsome, & Beck, 1956) was employed to assess children when they were in the fourth grade.

The CPT was selected as a performance measure of effortful controlled behavior because it provides data indicating attentional control (omission errors) and impulsive, dysinhibited behavior (commission errors and hit response time) (Epstein et al., 2003). Taken together, omission and commission errors neatly tap Kochanska & Murray's, (2002) factor "Supress/Initate." Because Supress/Initate is possibility the most salient EC factor (Tracy & Brotman, 2003) the CPT is a good fit for this study.

The young children's CPT was individually administered to subjects near the close of the 54 month laboratory visit. Situated in front of a 2 inch by 2 inch dot matrix computer display, subjects were required to differentially respond to rapidly (500 milliseconds) appearing target image (chair) and non-target, images (e.g., familiar objects, butterfly, fish, flower) that appear upon the screen in succession (1500 milliseconds interstimulus interval) by depressing a red one inch diameter button. The entire array of images including the target image consisted of ten simple objects. The examiner was directed to offer subjects the following instructions:

You are going to play a game with this black box. Let me tell you about it.

When you look at this window right here (point), pictures like a butterfly and a chair and a house will appear. Each time you see a picture of a chair press this button as fast as you can. Let me show you how to press the button. (Demonstrate.) Now you try. (NIHCD, 1995, p. 12)

The entire task takes approximately 7 minutes and 20 seconds. The young children's CPT is comprised of 22 blocks with each block including the presentation of 10 stimulus (images). The target stimulus (a chair) appears 20% of the time (two appearances) in each block. A comprehensive description of this measure's administration can be found by contacting the NICHD at <http://secc.rti.org>.

The CPT computer program automatically aggregated several statistics regarding each subjects' task performance including: 1) number of correct responses (coded as RC), 2) mean response time to all target responses (hit reaction time) (coded as L for late or VL for very late), 3) number of target stimulus to which the child failed to respond (omission errors coded as O), and 4) number of non-target stimulus to which the child

responded (commission errors coded as I). This data was summed across the testing session.

The A-X CPT was individually administered to subjects near the close of the fourth grade laboratory visit. Situated in front of a 2 inch by 2 inch computer display, subjects were required “to press a button each time the target stimulus, the letter X appears after the letter A” (NICHD, 2000, p. 1). Subjects’ ability to differentially respond to rapidly (200 milliseconds) appearing target (X after A) and non-target letters (XABCEFLMNP) that appear upon the screen in succession (1500 milliseconds interstimulus interval) by depressing a red one inch diameter button was recorded by the computer.

The CPT computer program automatically aggregates several statistics regarding each subjects task performance including: 1) number of correct responses (coded as RC), 2) mean response time to all target responses (hit reaction time) (coded as L for late or VL for very late), 3) number of target stimulus to which the child failed to respond (omission errors coded as O), and 4) number of non-target stimulus to which the child responded (commission errors). Three types of commission errors are recorded. These errors include errors of dysinhibited responding, X not preceded by A (coded I) and impulsive or erratic errors. Impulsive/erratic errors include responses to any incorrect letter other than A or X (coded IN) and responses to the letter A (coded IA).

The examiner was directed to offer subjects the following instructions:

This activity is called “A’s with X’s.” You will look at this window right here (point) and letters like A, B, and X will appear one at a time. You need to press this button when certain letters appear. The letter that you are looking for is the letter X. but the tricky part is that you don’t always

press the button when you see an X. The only time you press the button for X is when the letter A comes right before the letter X. So, if you see the letter A, get ready; if an X comes next, press the button. (NIHCD, 2000, p. 9)

The entire task takes approximately 15 minutes. The A-X CPT is comprised of 45 blocks with each block including the presentation of 12 stimulus (letters). The target stimulus (X after A) randomly appears 20% of the time (two appearances) in each block. A comprehensive description of this measure's administration can be found by contacting the NICHD at <http://secc.rti.org>.

The CPT is possibly the most popular and widely used performance measure for assessing vigilance, sustained attention, attentional control, impulsivity and response inhibition (Halperin, Sharma, Greenblatt, & Schwartz, 1991; Riccio et al., 2002).

Hundreds of studies have been conducted using the CPT to assess and quantify child behavior related to attentional control, and impulsivity. The CPT has well established construct validity (Halperin et al., 1991; Mirsky et al., 1991; Riccio et al., 2002) and adequate test-retest reliability ($r = .65-.74$) (Halperin et al., 1991). The CPT has established its utility for detecting ADHD like symptoms (Epstein et al., 2003; Overtom et al., 1998). The CPT has also established its sensitivity in detecting individual differences when comparing criterion groups, such as learning-disabled or attention-deficit versus controls (Barkley, DuPaul, & McMurray, 1990; Barkley, 1994; Barkley, Grodzinsky, & DuPaul, 1992; Campbell et al., 1994).

Research Design

A select longitudinal dataset from the NICHD SECC database was analyzed to better understand if securely attached children significantly differ from children who manifest insecure attachment behavior in regard to their subsequent formation of EC processes related to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity. The NICHD SECC has aggregated 12 years of their study's data. Data was collected in three distinct phases.

Phase I data included an assessment of cumulative social contextual risk and an assessment of maternal attachment security via a modified strange situation procedure designed for preschool children. Security of the child-mother attachment was assessed at 36 months by the modified version of Ainsworth's Strange Situation procedure described above. Cumulative social contextual risk was assessed via an index comprised of maternal responses to seven measures listed in Table 1. Each of these measures and the established risk threshold levels are described in detail above.

Table 1

Cumulative Social Contextual Risk Index

<i>Variable</i>	<i>Measurement Instrument</i>
Low Maternal Age	One month home visit And interview
Low Maternal Education	One month home visit And interview
Low Maternal Verbal Intelligence	The Peabody Picture Vocabulary Test-Revised (PPVT-R)
Low Economic Status	Income-to-needs ratio: Interview Data
Maternal Depression	Center for Epidemiological Studies Depression Scale (CES-D)
Low Social Support	The Relationships with Other People Questionnaire
Father Absence	Home Interview

Rather than treating the cumulative social contextual risk index as a dichotomous variable (high and low risk groups) this research will treat cumulative social contextual risk as a continuous variable. This continuous variable is a weighted risk score. Every subject's cumulative risk index score was calculated by aggregating the total number of risk factors which met or exceeded the specified theoretically derived threshold, a number between 0 to 7. A multiple regression was then conducted using the raw aggregate value of each risk factor as the predictor variable and the total number of risk factors which met or exceeded a specified theoretically derived threshold as the criterion variable. The weighted cumulative risk index score was then calculated by finding the sum of each risk factors' raw aggregate value and multiplying it by the unstandardized coefficient B for each risk factor. In this way each subject's weighted cumulative risk index score is presented as continuous variable. The unstandardized coefficient B for each risk factor is presented in the pre-analysis section of the results.

Phase I data collection began at the time of enrollment and continued over the entire 36 month period of Phase I. Research assistants from the sites visited each child at home, in child care (if used), and in a laboratory playroom.

Phase II data of relevance to this study included estimations of effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation collected during the 54 month laboratory visit. EC was measured using two methods, 1) maternal observational ratings and 2) a performance measure. Measures of observed EC were gathered via maternal report using the attention problems subscale of the CBCL (Achenbach, 1991). The Attention Problems scale is presented as a modified T-Score (scores less than or equal to fifty were coded by the NICHD SECC as 50). The Attention Problems scale is composed of items 1, 8, 10, 13, 17, 41, 45, 46, 61, 62, and 80. The possible range of scores is from 50 to 100. The actual range of scores is from 50 to 79, and higher scores indicate a stronger affinity to demonstrate attention problems. These problems include: acts young, can't concentrate, can't sit still, confused, day-dreams, impulsive, nervous, twitches, poor school work, clumsy, stares. The average T-Score ($M=53.68$) is similar to the average scores for the normative sample ($M=54.0$ for both boys and girls).

Estimations of subject's attentional control and impulsivity were derived by the administration of a Continuous Performance Task (CPT).

Estimations of effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation were collected again in Phase III during the fourth grade laboratory visit. Procedures similar to those employed in Phase II were replicated.

These included gathering maternal ratings of child behavior using the CBCL attention scale, and child CPT performance.

General Research Questions and Hypotheses

The general hypothesis asserts the quality of a young child's maternal attachment affects subsequent developmental outcomes related to effortfully controlled behavior. This hypothesis was tested through a series of multiple regressions, a series of Multivariate Analyses of Variance (MANOVA), and finally a series of Multivariate Analyses of Covariance (MANCOVA) with pairwise comparisons (Stevens, 2002).

The stability over time (54 months to fourth grade) of EC was examined to determine if any unknown intervening variables were affecting outcomes unexpectedly. Stability was assessed using two separate statistical procedures.

First, construct stability was evaluated by a series of multiple regressions. Multiple regression reveals the regression coefficients (or *B* coefficients) to the researcher. "Regression coefficients represent the *independent* contributions of each independent variable to the prediction of the dependent variable" (StatSoft, 2006, Unique Prediction and Partial Correlation section, para. 1). If observational ratings and performance scores of children's effortfully controlled behavior at 54 months (independent variables) are strong predictors of future effortfully controlled behavior (the dependant variable), then scores should be highly correlated, thus stable. Following this logic, a series of multiple regressions were used to determine the ability of children's effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation at 54 months to predict children's effortfully controlled behavior at fourth grade.

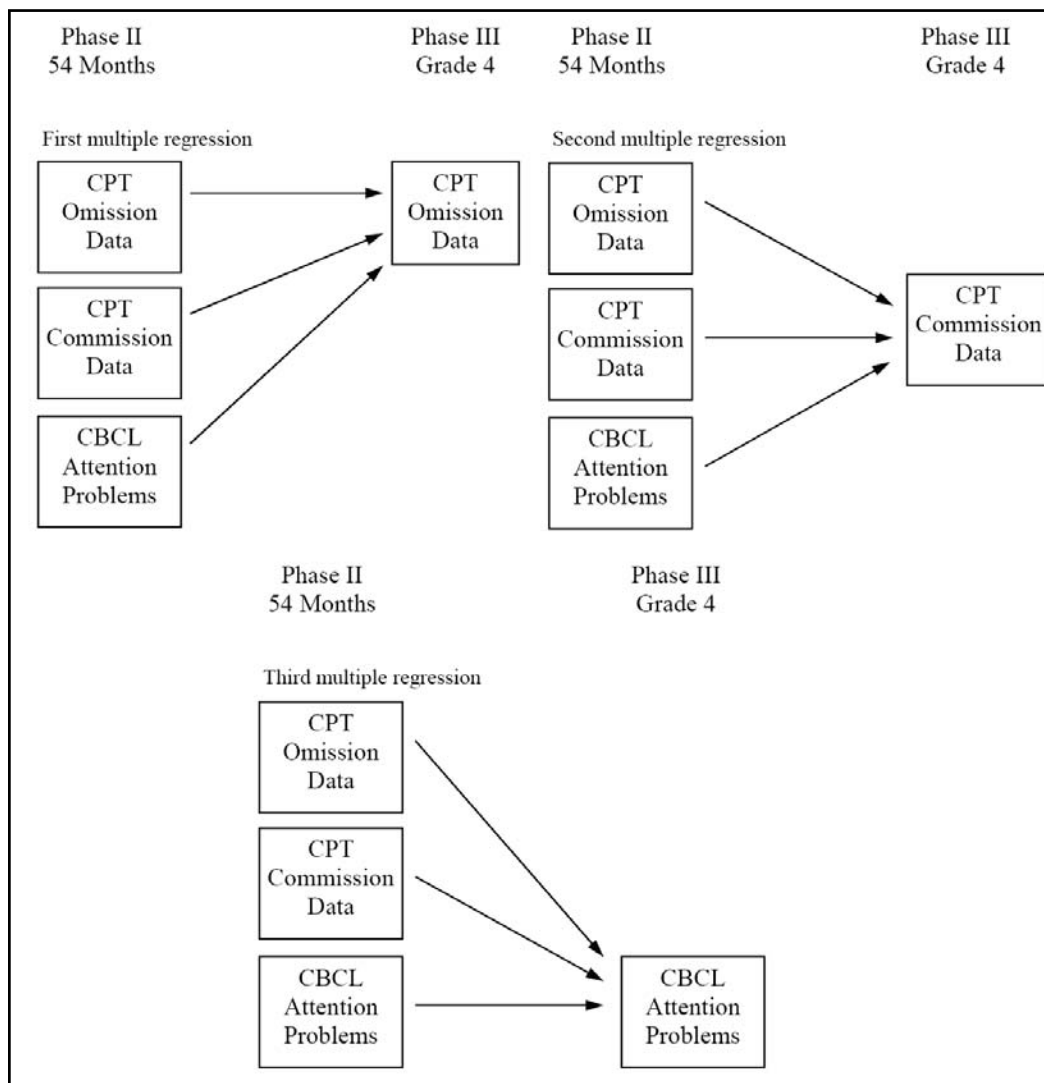


Figure 1. Three multiple regressions with all subjects

Three multiple regressions are employed to examine all subjects together (see Figure 1) and the same techniques (three multiple regressions) are employed to analyze boys and girls separately. Effortfully controlled behavior (maternal ratings on the CBCL attention scale and CPT performance) at 54 months of age served as independent variables for the first multiple regression. CPT Omission data from the fourth grade laboratory visit served as the criterion variable.

The second multiple regression is nearly the same, only the criterion variable is changed from CPT Omission performance to CPT Commission performance.

The third multiple regression is again nearly the same, only the criterion variable is changed to maternal ratings on the CBCL attention scale.

Next, a second set of analyses explored this same issue of construct stability, examining if children exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behavior at 54 months and fourth grade. The question was addressed by a series of one way, two level Multivariate Analyses of Variance (MANOVA) using time as the independent variable (the grouping variable) and effortfully controlled behavior (defined above) as the dependent variable (see Figure 2). Again, all subjects are analyzed together, and then boys and girls are analyzed separately.

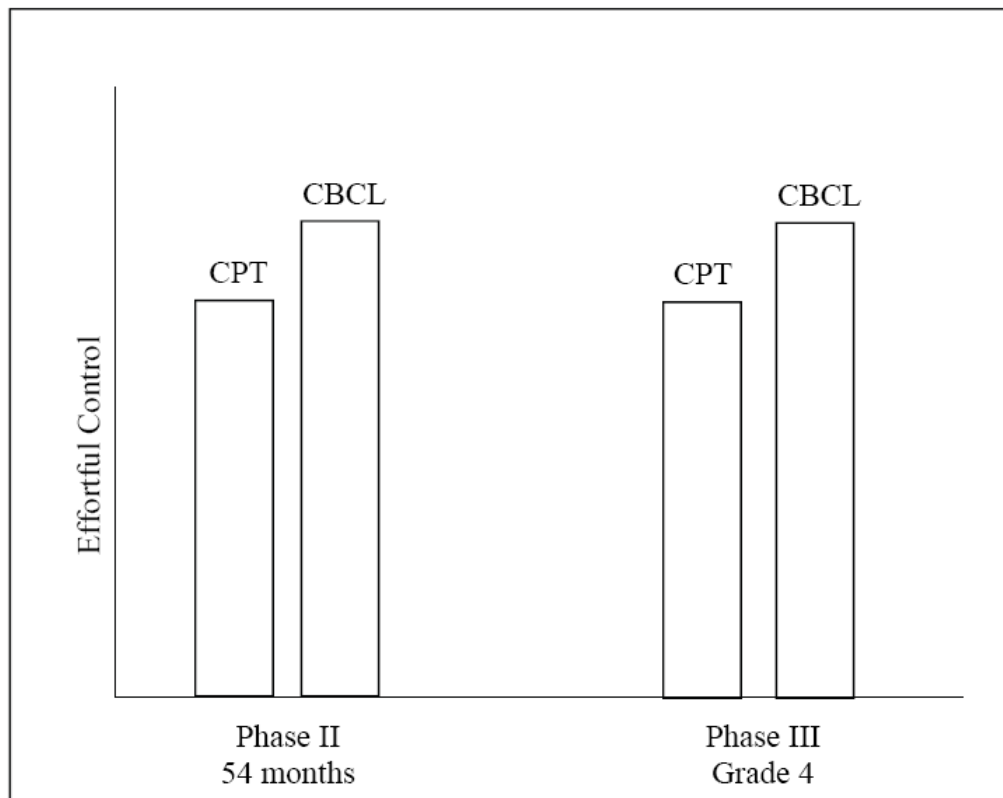


Figure 2. All subjects one way, two level MANOVA

To examine if children rated as manifesting secure versus insecure maternal attachment security significantly differed in regard to their effortfully controlled behavior after controlling for cumulative social contextual risk, a series of Multivariate Analyses of Covariance (MANCOVA) were conducted. As discussed above, the effects of cumulative social contextual risk have been demonstrated to affect children's cognitive and behavioral developmental outcomes (Cicchetti, 2002; Rutter & Sroufe, 2000). Because the current study was interested in discovering the unique variance contributed by maternal attachment security (the independent variable) to the subsequent formation of EC (the dependent variable) it was necessary to identify and control for the variance contributed by cumulative social contextual risk (a supplementary continuous independent variable or covariate). By definition a covariate is a variable (or set of variables) that contributes variance to, or effects, the dependent variable. The difference between an independent variable (i.e., maternal attachment security) and a covariate (i.e., cumulative social contextual risk) is the effect of the covariate is not of interest to the research. MANCOVA was selected for these analyses because of the necessity of controlling for the effects of cumulative social contextual risk (covariate) upon the dependant variable (EC). A series of three MANCOVAs analyzed ratings of maternal attachment security as the independent variable (two levels secure versus insecure). The cumulative social contextual risk index was treated as a covariate in these MANCOVAs and EC was the dependant variable. As in the previous analyses all subjects will be examined together, and then boys and girls will be analyzed separately.

Procedures

This study analyzed a select dataset from the NICHD SECC database to better understand the impact of children's early experiences on their overall development. The NICHD SECC provided an SPSS database that does not contain any identifying subject information. SPSS was used for all statistical analyses. Extracted data was analyzed to address the specific research questions described below.

The NICHD initiated the SECC study in 1989 to investigate the relationship between child care experiences and characteristics and children's developmental outcomes. The NICHD SECC is a comprehensive longitudinal study which aims to answer many questions about the relationship between child care experiences and characteristics and children's developmental outcomes.

The NICHD has employed researchers located at universities across the United States and at the NICHD, together providing multiple perspectives on and interests in child care research. This team of researchers has worked cooperatively to design and implement the study, and in 1991, enrolled a very diverse sample of children and their families at ten locations across the U.S.

In 1991, data collection for the study began when participating children were one month old. The study was arranged into several distinct data collection phases. Currently, data from Phases I, II, and III of the study are available to qualified researchers.

Through descriptions of every phase of the NICHD SECC including the recruitment practices employed (described above) as well as comprehensive inventories of all measurement techniques and procedures are offered at the NICHD SECC web site: <http://secc.rti.org>. Additionally, the NICHD SECC site provides detailed manuals

describing the exact practices implemented for all data collection. Examples of all non-copyrighted measurement instruments are included in the appendices, as are manuals describing the One month home interview, “Strange Situation” and the CPT laboratory procedure.

Data Analysis

Statistical analyses of the data utilized in this study include an a priori power analysis, descriptive statistics, a correlation matrix including all study variables, a series of chi-square analyses as a pre-analysis of construct stability, a series of multiple regressions, a series of Multivariate Analyses of Variance (MANOVA), and finally a series of Multivariate Analyses of Covariance (MANCOVA) with pairwise comparisons (Stevens, 2002).

The purpose of conducting an a priori power analysis is to establish the minimum number of participants needed to achieve adequate power for deriving small (.15) effect size using three (CBCL, CPT, and the covariate) two level (secure versus insecure) predictors at a .01 alpha level. Power analysis was calculated with tables from Stevens (2002) power tables (p. 626).

Table 2

A priori Statistical Analysis

Effect Size	Alpha	Power	Predictors	Minimum N per group
.15	.01	.80	3	155
.15	.01	.90	3	190

The relatively large number of participants 775 will provide ample power to detect a small effect size.

Descriptive statistics are calculated to explicate the demographic break down of the sample in regard to sex, ethnicity, and the proportion of subjects above the specified risk threshold on each of the factors comprising the Cumulative Social Contextual Risk Index. Additional descriptive statistics are offered indicating the prevalence distribution of the subjects' number of social contextual risk factors and subjects' prevalence distribution of maternal attachment security. Finally, descriptive statistics demonstrating the summary distribution of mean, standard deviation, and range for each dependant variable measure of effortful control is presented in the results section.

A collection of correlation matrixes are presented in the results section to determine the extent of the relationship between all of the studies variables. A principal component analysis is presented in the results section to identify the principle component structure of the various measures of effortful control. This analysis was conducted to provide empirical support for the theory informing the selection of CPT scores chosen to represent attentional control, impulsivity, and emotional regulation.

Research Questions and Hypotheses

Two questions are addressed by this study. The first question concerns the stability of the construct of EC over time. The second research question addresses the central theme of the study; do securely attached children significantly differ from children who manifest insecure attachment behavior in regard to their subsequent formation of EC processes related to attentional control, impulsivity and emotional regulation, after controlling for the effects of social contextual adversity? Hypotheses related to each of these questions were proposed. Each hypothesis, the rationale related to the selection of

statistical analysis procedures, and a discussion of the associated assumptions related to the selected statistical analyses are articulated.

Research Question 1

The question, “Does effortfully controlled behavior related to attentional control, impulsivity and emotional regulation as measured by, maternal ratings on the CBCL attention scale and CPT performance, remain stable from 54 months of age to fourth grade?” will be answered by testing four hypotheses. The first two hypotheses related to this question concern the ability of observational and performance data collected in phase II during the 54 month laboratory visit to predict the outcome of observational and performance data collected in phase III during the fourth grade laboratory visit.

Hypothesis #1

Effortfully controlled behaviors related to attentional control, impulsivity and emotional regulation as measured by, maternal ratings on the CBCL attention scale and CPT performance, measured at 54 months of age will predict similar effortfully controlled behaviors measured at fourth grade.

Hypothesis #2

Effortfully controlled behaviors related to attentional control, impulsivity and emotional regulation as measured by, maternal ratings on the CBCL attention scale and CPT performance, at 54 months of age will predict similar effortfully controlled behaviors measured at fourth grade for boys and girls studied separately.

Statistical Analysis

These two hypotheses were tested by use of a series of Multiple Regressions. To test the first hypothesis three multiple regressions were necessary because each of the three

dependent variables were examined separately. The second hypothesis necessitated a series of six Multiple Regressions because the same analysis was conducted on the sample's boys and girls separately. The intention of this analysis was to discover which of the three independent variables entered best predicts the value of the criterion variable (CBCL attention scale rating, CPT Omission performance, or CPT Commission performance at 11 years). The second and third multiple regression are nearly the same only the criterion variable is changed.

Predictor Variable: Maternal ratings on the CBCL attention scale and CPT performance at 54 months of age.

Criterion Variable: Maternal ratings on the CBCL attention scale or CPT performance at 11 years of age.

Rationale for Selection of Statistical Analysis

If observational ratings and performance scores of children's effortfully controlled behavior at 54 months (independent variables) are strong predictors of future effortfully controlled behavior (the dependant variable), then scores should be highly correlated, thus stable. Following this logic, a series of multiple regressions were used to determine the ability of children's effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation at 54 months to predict children's effortfully controlled behavior at fourth grade. Multiple regression reveals the regression coefficients (or *B* coefficients) to the researcher. "Regression coefficients represent the *independent* contributions of each independent variable to the prediction of the dependent variable" (StatSoft, 2006, Unique Prediction and Partial Correlation section, para. 1). Multiple regression allows a researcher to identify which of several the independent or

predictor variables best predict a dependent or criterion variable (StatSoft, 2006).

Multiple regression analysis allows the researcher to ask the general question which independent variable is the best predictor of ... (StatSoft, 2006).

Assumptions

A potential for difficulty running multiple regressions (and other multivariate statistics), called multicollinearity, exists when the linear-intercorrelations between independent variables (predictors) are moderate to high (Stevens, 2002). High levels of intercorrelations between independent variables (multicollinearity) create three statistical problems. The first of these issues relates to the multiple correlation coefficient, expressed as R . R can be any value from 0 to +1. The closer R is to +1 the stronger the linear association between the predictor and the criterion. Perfect multicollinearity results in an R of 0 indicating no linear association between the dependent variable and the independent variables, essentially restricting researcher's ability to identify the unique variance contributed by any specific predictor. The second problem of multicollinearity involves researcher's inability to identify the importance of specific predictors due to the redundancy (amount of shared variance) of the independent variables. Finally, multicollinearity produces an unstable prediction equation as a result of increased variances of R (Stevens, 2002). To assess for multicollinearity the simple linear-correlations between independent variables are examined as are the predictors' variance inflation factors (Stevens, 2002).

In addition to multicollinearity, multiple regression analyses rely upon four additional assumptions: linearity, normality, independence, and homoscedasticity. The assumption of linearity relies upon the existence of a linear relationship between

variables. In practice the assumption of linearity can not be readily confirmed. The suggested procedure to check for linearity involves an examination of a bivariate scatterplot. If curvature in the X to Y relationship is apparent, the variables can be transformed, or the researcher can explicitly allow for nonlinear components (StatSoft, 2006). Multiple regression analysis is relatively resilient to minor deviations from linearity (StatSoft, 2006).

The assumption of normality concerns an expectation of a normal distribution of residuals or error (expected minus observed values) (StatSoft, 2006). Multivariate normality is the assumption that all variables and all combinations of the variables conform to a normal distribution. The suggested procedure to check the assumption of normality involves a review of histograms for the residuals and an examination of normal probability plots for skewness and/or kurtosis. Nonsymmetrical distributions are skewed either positively or negatively. Kurtosis references the distribution's degree of peakedness. Normal distributions' skewness and Kurtosis values are 0, values greater than +1.5 or less than -1.5 are considered extreme when divided by the standard error of measurement (Tabachnick & Fidell, 2007). If the major variables of interest do not conform to a normal distribution then the assumption is likely violated. Multiple regression analysis is relatively "robust with regard to violations of this assumption" (StatSoft, 2006, Normality Assumption section, para. 1).

The assumption of independence relates to an assumption that errors are independent, meaning that subjects are responding independently of one another (Stevens, 2002). The assumption of homoscedasticity assumes the variance of residuals is spread consistently around the regression line (the same across all levels of the

predictor), so the variance of errors across all values of the predictors is constant. When the converse is found (variance of errors differing at different values of the predictor), heteroscedasticity is indicated. Homoscedasticity can be evaluated by examining residual scatter plots (plots of the standardized residuals) (Stevens, 2002). Serious distortion of findings, gravely weaken analyses and the risk of a Type I error is elevated when scatter plots of the standardized residuals indicate marked heteroscedasticity. However minor heteroscedasticity has little effect on significance tests (Tabachnick & Fidell 1996).

Hypothesis #3

Children will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by, maternal ratings on the CBCL attention scale and CPT performance.

Hypothesis #4

Boys and girls studied separately will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by, maternal ratings on the CBCL attention scale and CPT performance.

Statistical Analysis

To determine if children exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behavior at 54 months and fourth grade. Hypotheses #3 and 4 were tested with a series of one way, two level Multivariate Analyses of Variance (MANOVA). Time served as the independent variable (the

grouping variable) and effortfully controlled behavior (defined above) as the dependent variable. As before, all subjects were analyzed together, and then boys and girls were analyzed separately.

Independent Variable: Time (54 months and 11 years).

Dependant Variable: Effortfully controlled behavior as measured by maternal ratings on the CBCL attention scale and CPT performance.

Rationale for Selection of Statistical Analysis

MANOVA was selected because it is the most expeditious method of determining if children grouped by time (54 months and fourth grade) exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behavior. A multivariate analysis was necessary because the dependant variable (the construct of EC) was comprised of two separate measures (maternal ratings on the CBCL attention scale and CPT performance).

Assumptions

MANOVA rely upon five assumptions: multicollinearity, independence, linearity, normality, and homogeneity of variance-covariance. The assumptions of multicollinearity, independence, linearity, and normality were described above. The assumptions of homogeneity of variance-covariance matrices were examined for robustness using the Box's M test. The Box's M test is significant when the variance across dependent measures differs. The Box's M test is also sensitive to violations of the assumption of multivariate normality (Tabachnick & Fidell, 2007).

Research Question #2

The question: “Does security of attachment to a primary care provider at 36 months of age, affect subsequently developed effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation, as measured by, maternal ratings on the CBCL attention scale and CPT performance, at fourth grade, after controlling for the effects of social contextual adversity?” will be answered by testing two hypotheses. These hypotheses concern the manifest differences in effortfully controlled behavior between children assessed as enjoying a secure maternal attachment and children rated as insecurely attached to their mothers after controlling for cumulative social contextual risk.

Hypothesis #5

Children that are insecurely attached at 36 months will exhibit more poorly developed effortful controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, than peers that are securely attached at 36 months after taking social contextual adversity into account.

Hypothesis #6

When boys and girls are studied separately, boys and girls that are insecurely attached at 36 months will exhibit more poorly developed effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation, than peers that are securely attached at 36 months after taking social contextual adversity into account.

Statistical Analysis

To examine if securely and insecurely attached children significantly differed in regard to effortfully controlled behavior after controlling for cumulative social contextual

risk, a series of Multivariate Analyses of Covariance (MANCOVA) were conducted.

Hypotheses #5 and #6 were tested with a series of three one way, two level

MANCOVAs. The three MANCOVAs analyzed ratings of maternal attachment security as the independent variable (two levels secure versus insecure). The cumulative social contextual risk index was treated as a covariate in these MANCOVAs and EC was the dependant variable. As in the previous analyses all subjects were examined together, and then boys and girls were analyzed separately.

Independent Variable: Maternal attachment security classification: two level classification: secure (0) insecure (1).

Covariate: Cumulative social contextual risk.

Dependant Variable: Effortfully controlled behavior as measured by maternal ratings on the CBCL attention scale and CPT performance at fourth grade.

Rationale for Selection of Statistical Analysis

MANCOVA was selected for these analyses because of the necessity of controlling for the effects of cumulative social contextual risk (covariate) upon the dependant variable (EC). As discussed above, the effects of cumulative social contextual risk have been demonstrated to affect children's cognitive and behavioral developmental outcomes (Cicchetti, 2002; Rutter & Sroufe, 2000). Because the current study was interested in discovering the unique variance contributed by maternal attachment security (the independent variable) to the subsequent formation of EC (the dependent variable) it was necessary to identify and control for the variance contributed by cumulative social contextual risk (a supplementary continuous independent variable or covariate). By definition a covariate is a variable (or set of variables) that contributes variance to, or

effects, the dependent variable. The difference between an independent variable (i.e., maternal attachment security) and a covariate (i.e., cumulative social contextual risk) is the effect of the covariate is not of interest to the research.

Assumptions

MANCOVA rely upon six assumptions: multicollinearity, independence, linearity, normality, homogeneity of variance-covariance, and homogeneity of regression. The assumptions of multicollinearity, independence, linearity, normality and homogeneity of variance-covariance were described above. The assumption of homogeneity of regression pertains to the slopes of the regression lines formed by the categorical variables which should be the same for each group. Violation of this assumption indicates a significant interaction effect between the covariate and the independent variable, leading to an increased likelihood of Type I errors (mistakenly accepting a null hypothesis). To check the assumption of homogeneity of regression interactions between the covariate and each independent factor are examined.

CHAPTER IV

RESULTS

The purpose of the study is to provide an improved understanding of the association between children's early experiences and ensuing developmental outcomes. This goal is accomplished by exploring the connection between the security of young children's maternal attachment relationships and the subsequent formation of the child's executive control (EC) system. Specifically, the aim of the study is to explore if securely versus insecurely attached children differ in regard to their subsequent formation of EC processes related to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity. To that end, a select dataset from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care (SECC) database was analyzed.

The current study's sample includes 775 of the original 1,364 families with healthy newborns who were enrolled in the NICHD SECC. Missing data forced the exclusion of 589 subjects from the current study.

The results will be presented as follows. Descriptive statistics will show the demographic information of the study's sample and of each of the study's variables. Pre-analyses will include 1) a set of correlation matrixes between all of the study's variables, 2) a principal component analysis designed to identify the principle component structure of the CPT, and 3) a multiple regression analysis of the each of the Social Contextual Risk Factors to the total number of risk factors above threshold. The unstandardized coefficient *Bs* for each risk factor are presented because the unstandardized coefficient *Bs* are used in computing the

weighted cumulative risk index score. Next, the statistical assumptions related to each of the main analyses are tested and presented to guarantee the correctness of performing the statistical analyses for each of the research questions. Finally, the results of each of the main analyses are presented.

Descriptive Statistics

Descriptive statistics are calculated to explicate the demographic break down of the sample in regard to sex, ethnicity, and the proportion of subjects above the specified risk threshold on each of the factors comprising the Cumulative Social Contextual Risk Index. These data are displayed by frequency distribution. A frequency distribution is simply an organized aggregation of subjects by any criteria, such as numbers of boy versus girl subjects. These data are presented in Tables 3 through 5.

Demographic Information

Table 3

Frequency Distribution of Sex

Sex	n	Percent of Sample
Boys	376	48.5
Girls	399	51.5

Table 4

Frequency Distribution of Ethnicity

Ethnicity	n	Percent of Sample
American Indian, Eskimo, Aleut	1	.1
Asian or Pacific Islander	9	1.2
Black or African American	83	10.7
White	648	83.6
Mixed-Other	34	4.4

Table 5

Frequency Distribution of Hispanic Extraction

Hispanic Extraction	n	Percent of Sample
Non-Hispanic	728	93.9
Hispanic	47	6.1

The current study includes a sample of 775 subjects, 48.5% are boys and 51.5% girls. The sample's distribution of ethnicity was relatively well matched with the distribution of ethnicity in the United States based upon demographic data gathered from the United States Census Bureau (U.S. Census Bureau, 2007).

The study's sample included .1% Native Americans, 1.2% Asians or Pacific Islanders, 10.7% Blacks or African Americans, 83.6% Whites, and 4.4% mixed or others. The sample was 6.1% Hispanic. A separate table reporting the frequency distribution of subjects of Hispanic extraction was thought necessary because people of many ethnic backgrounds may be of Hispanic extraction. As such a separate accounting of subjects of Hispanic extraction seemed appropriate. Census Bureau data indicates the following

national distribution of ethnicity in the United States: Native Americans 1%, Asians or Pacific Islanders 4.3%, Blacks or African Americans 12.8%, Whites 80.2%. Persons reporting two or more races 1.5%, and Persons of Hispanic or Latino origin 14.4%. Table 6 presents a side by side comparison of National Census Bureau data and this study's distribution of subjects by ethnicity including Hispanic extraction.

Table 6

Side by Side Comparison of Current Study to National Census Bureau Data

Ethnicity	Percent of Current Study's Sample	Percent of United States Population
American Indian, Eskimo, Aleut	.1	1
Asian or Pacific Islander	1.2	4.3
Black or African American	10.7	12.8
White	83.6	80.2
Mixed-Other	4.4	1.5
Hispanic	6.1	14.4

The current study under represents Native Americans, Asians, and persons of Hispanic or Latino origin, to a lesser degree African Americans are underrepresented. The current study presents a slight overrepresentation of whites and persons of mixed heritage.

Social Contextual Risk Factors

Descriptive statistics are offered in Table 7 indicating the prevalence distribution of subjects by social contextual risk factors.

Table 7

Prevalence Distribution by Social Contextual Risk

Social Contextual Risk Factors	n	Percent of Sample
Low Maternal Age	35	4.5
Low Maternal Education	210	27.1
Low Maternal Verbal Intelligence	95	12.3
Low Economic Status	98	12.6
Maternal Depression	233	30.1
Low Social Support	5	.6
Father Absence	27	3.5
No Social Adversity	401	51.7

As is shown in Table 7, 401 (51.7%) of this study's 775 subjects did not report any social contextual risk factors above the specified risk thresholds. Maternal Depression was endorsed (as defined by a score on any two administrations of the Center for Epidemiological Studies Depression Scale (CES-D) falling at or above 16 points) by 233(30.1%) of the study's mothers. Low Maternal Education was found in 210 (27.1%) of the study's mothers who indicated no more than high school education achieved by the time of the one month home visit. Low Economic Status impacted 98 (12.6%) study families who indicated living below the established poverty level (income-to-needs ratio falling at <1) during four or more of the six measurement periods. Ninety-five (12.3%) study mothers achieved scores on the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn & Dunn, 1981) ≤ 80 . These mothers are classified for the purposes of this study as Low Maternal Verbal Intelligence. Thirty-Five (4.5%) of the participating mothers gave birth to a child enrolled in the study on or before their 19th birthday. These subjects are classified as Low Maternal Age. Father Absence was endorsed by 27 (3.5%) of the

study's mothers who indicated not only a consistent paternal absence from the child's home living environment over the child's first 36 months of life, but also that no paternal contact with the child had occurred. Low Social Support was endorsed (as defined by a mean score on any two administrations of the CES-D falling at or below 2.5 points) by 5 (.6%) study mothers.

Table 8 shows the prevalence distribution by number of social contextual risk factors.

Table 8

Unique Frequency Distribution of Subjects Based Upon Number of Social Contextual Risk Factors

Number of Social Contextual Risk Factors	n	Percent of Sample
No Social Contextual Risk Factors	401	51.8
1 Social Contextual Risk Factor	191	24.6
2 Social Contextual Risk Factors	99	12.8
3 Social Contextual Risk Factors	42	5.4
4 Social Contextual Risk Factors	26	3.4
5 Social Contextual Risk Factors	12	1.5
6 Social Contextual Risk Factors	4	0.5
7 Social Contextual Risk Factors	0	0

As is shown in Table 8, 401 (51.7%) of this study's 775 subject did not report any social contextual risk factors above the specified risk thresholds. One hundred ninety one or 24.6% of the study's families were above the specified risk threshold for only one risk factor. Nearly ½ that number, 99 or 12.8% are above the specified risk threshold for two risk factors. The number is more then halved again to 42 or 5.4% of the study's families when looking at three risk factors. Twenty six or 3.4% of the study's families are above the specified risk threshold for four risk factors and 12 or 1.5% of the study's families are

above the specified risk threshold for five risk factors. Only 4 or .5% of the study's families are above the specified risk threshold for six risk factors and no families are above the specified risk threshold for all seven of the risk factors.

Maternal Attachment Security

Table 9 shows subjects' prevalence distribution of maternal attachment security.

Table 9

Frequency Distribution of Maternal Attachment Security

Maternal Attachment Security	n	Percent of Sample
Insecure	275	35.5
Secure	500	64.5

Data collected at 36 months employing a modified Strange Situation procedure (described in Methods) indicated 275 (35.5%) of this study's 775 subjects were insecurely attached. Secure maternal attachment was found in 500 (64.5%) of this study's 775 subjects.

Boys

Table 10 shows boys' prevalence distribution of maternal attachment security.

Table 10

Boys' Frequency Distribution of Maternal Attachment Security

Maternal Attachment Security	n	Percent of Sample
Insecure	117	31.1
Secure	259	68.9

Data collected at 36 months employing a modified Strange Situation procedure (described in Methods) indicated 117 (31.1%) of this study's 376 boys were insecurely attached. Secure maternal attachment was found in 259 (68.9%) of this study's 378 boys.

Girls

Table 11 shows girls' prevalence distribution of maternal attachment security.

Table 11

Girls' Frequency Distribution of Maternal Attachment Security

Maternal Attachment Security	n	Percent of Sample
Insecure	158	39.6
Secure	241	60.4

Data collected at 36 months employing a modified Strange Situation procedure (described in Methods) indicated 158 (39.6%) of this study's 399 girls were insecurely attached. Secure maternal attachment was found in 241 (60.4%) of this study's 399 girls.

Measures of Effortful Control

Descriptive statistics demonstrating the summary distribution of mean, standard deviation, and range for each dependant variable measure of effortful control is presented in Table 12. Raw scores and T scores are presented for CPT data.

Table 12

Summary Distribution of Mean, Standard Deviation, and Range: Measures of Effortful Control

Dependant Effortful Control Variables	N	Minimum	Maximum	Mean	Standard Deviation
CPT: Raw Number of Omission Errors - 54 Months	775	0	41	8.99	7.62
CPT: Omission Errors T-Score - 54 Months	775	37.97	92.05	49.80	10.03
CPT: Raw Number of Commission Errors 54 Months	775	0	154	13.30	20.14
CPT: Commission Errors T-Score - 54 Months	775	43.34	115.64	49.58	9.46
CBCL: Maternal Responses to Attention Problems Scale T-Score - 54 Months	775	50	79	53.5	5.04
CPT: Raw Number of Omission Errors - Grade 4	775	0	51	4.03	5.43
CPT: Omission Errors T-Score - Grade 4	775	42.68	131.78	49.71	9.49
CPT: Raw Number of Commission Errors Grade 4	775	0	94	7.77	10.21
CPT: Commission Errors T-Score - Grade 4	775	43.24	119.14	49.51	8.25
CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4	775	50	89	53.49	5.99

The average number of CPT omission errors for children at the 54 month measurement period for the 775 participants was 8.99 ($SD = 7.62$). The range spanned from 0 errors to 41 errors. The average number of CPT commission errors for children at the 54 month measurement period for the 775 participants was 13.3 ($SD = 20.1$). The large standard deviation relative to the mean number of Commission errors is likely a function of the pattern of responding executed by 4 ½ - year-old children who respond impulsively. Such children are likely to demonstrate a very large number of errors. The range spanned from 0 errors to 154 errors (at maximum nearly 60 more errors than demonstrated almost 5 years later on a very similar test that was almost twice as long in duration. The average T-score of maternal responses on the CBCL Attention Problems Scale at the 54 month measurement period for the 775 participants was 53.3 ($SD = 5.0$). The range spanned from T-scores of 50 to 79.

The average number of CPT omission errors for children at the fourth grade measurement period for the 775 participants was 4 ($SD = 5.4$). The range spanned from 0 errors to 51 errors. The average number of CPT commission errors for children at the fourth grade measurement period for the 775 participants was 7.8 ($SD = 10.2$). The range spanned from 0 errors to 94 errors. The average T-score of maternal responses on the CBCL Attention Problems Scale at the fourth grade measurement period for the 775 participants was 53.3 ($SD = 6.0$). The range spanned from T-scores of 50 to 89.

Boys

Descriptive statistics demonstrating the summary distribution of mean, standard deviation, and range for each dependant variable measure of effortful control of only the boys is presented in Table 13. Raw scores and T scores are presented for CPT data.

Table 13

Boys Only Summary Distribution of Mean, Standard Deviation, and Range: Measures of Effortful Control

Dependant Effortful Control Variables	N	Minimum	Maximum	Mean	Standard Deviation
CPT: Raw Number of Omission Errors - 54 Months	376	0	41	9.61	8.10
CPT: Omission Errors T-Score - 54 Months	376	37.97	92.05	50.63	10.66
CPT: Raw Number of Commission Errors 54 Months	376	0	154	18.25	24.35
CPT: Commission Errors T-Score - 54 Months	376	43.34	115.64	51.91	11.43
CBCL: Maternal Responses to Attention Problems Scale T-Score - 54 Months	376	50	78	53.7	4.61
CPT: Raw Number of Omission Errors - Grade 4	376	0	43	4.52	5.94
CPT: Omission Errors T-Score - Grade 4	376	42.68	117.80	50.57	10.38
CPT: Raw Number of Commission Errors Grade 4	376	0	94	10.59	12.00
CPT: Commission Errors T-Score - Grade 4	376	43.24	119.14	51.79	9.69
CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4	376	50	89	53.49	5.78

The average number of CPT omission errors for boys at the 54 month measurement period for the 376 boys was 9.61 ($SD = 8.10$). The range spanned from 0 errors to 41 errors. The average number of CPT commission errors for children at the 54 month measurement period for the 376 boys was 18.25 ($SD = 24.35$). The range spanned from 0 errors to 154 errors. The average T-score of maternal responses on the CBCL Attention Problems Scale at the 54 month measurement period for the 376 participants was 53.7 ($SD = 4.61$). The range spanned from T-scores of 50 to 78.

The average number of CPT omission errors for children at the fourth grade measurement period for the 376 boys was 4.52 ($SD = 5.94$). The range spanned from 0 errors to 43 errors. The average number of CPT commission errors for children at the fourth grade measurement period for the 376 participants was 10.59 ($SD = 12.00$). The range spanned from 0 errors to 94 errors. The average T-score of maternal responses on the CBCL Attention Problems Scale at the fourth grade measurement period for the 376 boys was 53.49 ($SD = 5.78$). The range spanned from T-scores of 50 to 89.

Girls

Descriptive statistics demonstrating the summary distribution of mean, standard deviation, and range for each dependant variable measure of effortful control of only the girls is presented in Table 14. Raw scores and T scores are presented for CPT data.

Table 14

Girls Only Summary Distribution of Mean, Standard Deviation, and Range: Measures of Effortful Control

Dependant Effortful Control Variables	N	Minimum	Maximum	Mean	Standard Deviation
CPT: Raw Number of Omission Errors - 54 Months	399	0	32	8.40	7.11
CPT: Omission Errors T-Score - 54 Months	399	37.97	80.11	49.03	9.36
CPT: Raw Number of Commission Errors 54 Months	399	0	113	8.63	13.61
CPT: Commission Errors T-Score - 54 Months	399	43.34	96.39	47.39	6.39
CBCL: Maternal Responses to Attention Problems Scale T-Score - 54 Months	399	50	79	53.88	5.39
CPT: Raw Number of Omission Errors - Grade 4	399	0	51	3.56	4.87
CPT: Omission Errors T-Score - Grade 4	399	42.68	131.78	48.90	8.51
CPT: Raw Number of Commission Errors Grade 4	399	0	60	5.11	7.25
CPT: Commission Errors T-Score - Grade 4	399	43.24	91.68	47.36	5.85
CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4	399	50	88	53.49	6.18

The average number of CPT omission errors for girls at the 54 month measurement period for the 399 girls was 8.40 ($SD = 7.11$). The range spanned from 0 errors to 32 errors. The average number of CPT commission errors for girls at the 54 month measurement period for the 399 participants was 8.63 ($SD = 13.61$). The range spanned from 0 errors to 113 errors. The average T-score of maternal responses on the CBCL Attention Problems Scale at the 54 month measurement period for the 399 girls was 53.88 ($SD = 5.39$). The range spanned from T-scores of 50 to 79.

The average number of CPT omission errors for girls at the fourth grade measurement period for the 399 girls was 3.56 ($SD = 4.87$). The range spanned from 0 errors to 51 errors. The average number of CPT commission errors for children at the fourth grade measurement period for the 399 participants was 5.11 ($SD = 7.25$). The range spanned from 0 errors to 60 errors. The average T-score of maternal responses on the CBCL Attention Problems Scale at the fourth grade measurement period for the 399 girls was 53.49 ($SD = 6.18$). The range spanned from T-scores of 50 to 88.

Pre-Analyses Statistics

To best represent cumulative social contextual risk, the study's covariate, a single continuous index score was created. Rather than treating the cumulative social contextual risk index as a dichotomous variable (high and low risk groups) this research will treat cumulative social contextual risk as a continuous variable. This Cumulative Weighted Social Contextual Risk Index Score (CWSCRIS) was designed to account for as much of the variance generated by the various social contextual risk factors as possible. To this end, the CWSCRIS is a weighted risk score. Every subject's cumulative aggregate of risk factors was calculated by counting the total number of risk factors which met or exceeded

the specified theoretically derived threshold, a number between 0 to 7. This simple score is referred to as the Total Aggregate Social Contextual Risk Score (TASCRS). A multiple regression was then conducted using the raw aggregate value of each risk factor as the predictor variable and the total number of risk factors which met or exceeded a specified theoretically derived threshold as the criterion variable. The CWSCRIS was then calculated by finding the sum of each risk factors' raw aggregate value and multiplying it by the unstandardized coefficient B for each risk factor. In this way each subject's weighted cumulative risk index score is presented as a predicted continuous variable. The unstandardized coefficient B for each risk factor is presented in Table 15.

Table 15

Summary of Multiple Regression Analysis for Social Contextual Risk Factors for Predicting Total Aggregated Social Contextual Risk

Social Contextual Risk Factors	Unstandardized Coefficients		
	B	Standard Error	Significance
Maternal Age	1.083	0.059	0.000
Maternal IQ	1.029	0.039	0.000
Low Maternal Education	0.993	0.029	0.000
Father Absence	0.387	0.030	0.000
Maternal Depression	0.261	0.008	0.000
Maternal Rating of Social Support	0.228	0.049	0.000
Low Economic Status	0.159	0.09	0.000

Note. $R^2 = .94$

As is clear from Table 15, Maternal Age, Maternal IQ, and Low Maternal Education are the most powerful predictors of cumulative social contextual risk (the Total Aggregate Social Contextual Risk Score). The remaining risk factors are far less powerful predictors of the TASCERS. Therefore, although these later variables are included, they carry less weight in the overall cumulative social contextual risk variable.

The most likely explanation of the relatively higher unstandardized coefficient *B* of Maternal Age, Maternal IQ, and Low Maternal Education relates to the cascading social consequences of each of these individual risk factors. For example, when young women have children very often their new responsibilities as parents will negatively impact their academic achievement, and interfere with their education. Additionally, young mothers frequently are unmarried and their pregnancies are very often unplanned. Less education often results in lower earning potential (this is especially true for young single mothers). These circumstances contribute to maternal depression, and weakened social supportive systems. In a similar fashion lower Maternal IQ contributes to problems with academic achievement, and interferes with their education. As stated above less education often results in lower earning potential. The internal consistency reliability (cronbach's alpha) of the CWSCRIS was .627.

To verify the appropriateness of employing the CWSCRIS rather than simply employing the TASCERS, descriptive statistics including the minimum, maximum, mean, and standard deviation of the CWSCRIS and the TASCERS are shown in table 16.

Table 16

Summary Distribution of Mean, Standard Deviation, and Range: Social Contextual Risk Scores

Social Contextual Risk Scores	n	Minimum	Maximum	Mean	Standard Deviation
Cumulative Weighted Social Contextual Risk Index Score	775	0	3.91	0.557	0.841
Total Aggregate Social Contextual Risk Score	775	0	6	0.907	1.239

The average Cumulative Weighted Social Contextual Risk Index Score of the 775 study participants was 0.557 ($SD = 0.841$). The range spanned from 0 risks to a weighted risk score of 3.91. The average Total Aggregate Social Contextual Risk Score for the 775 study participants was 0.907 ($SD = 1.239$). The range spanned from 0 errors to 6 risk factors. Figure 3 displays a side by side comparison of the frequency distribution histogram of the Cumulative Weighted Social Contextual Risk Index Score and the frequency distribution of the Total Aggregate Social Contextual Risk Score.

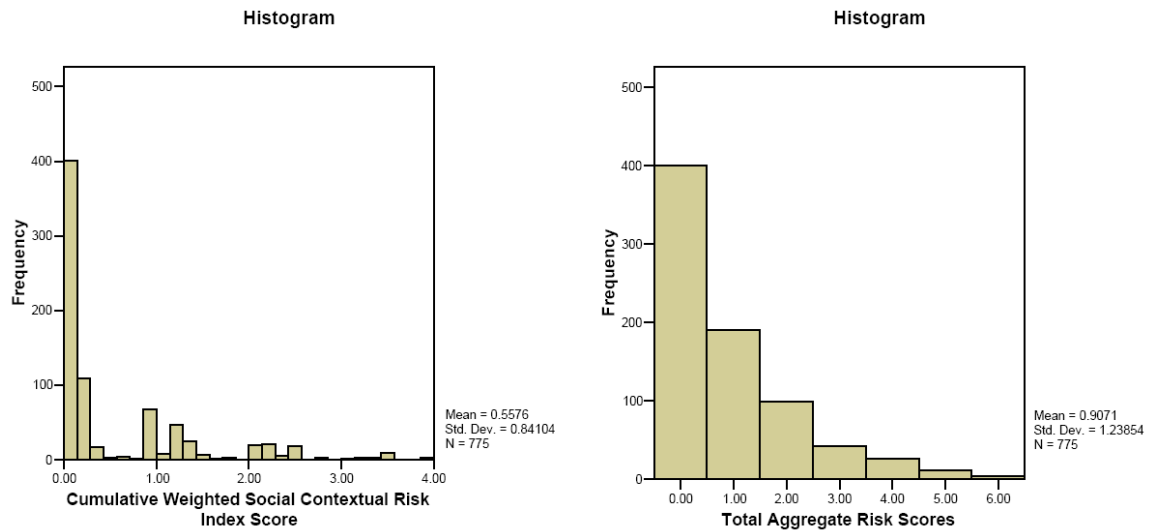


Figure 3. Comparison of risk score frequency distributions.

The histograms presented in Figure 3 illustrate the similarity of the frequency distributions of Cumulative Weighted Social Contextual Risk Index Scores and the Total Aggregate Social Contextual Risk Score. Both distributions are reflective of the fact that more than half of the sample's risk scores are 0. A strong positive correlation exists (.938, $p < 0.01$) between the TASCRES and CWSCRIS supporting the suitability and appropriateness of employing the CWSCRIS .

Figure 4 displays the bivariate scatter plot of the Cumulative Weighted Social Contextual Risk Index Scores and the Total Aggregate Social Contextual Risk Score.

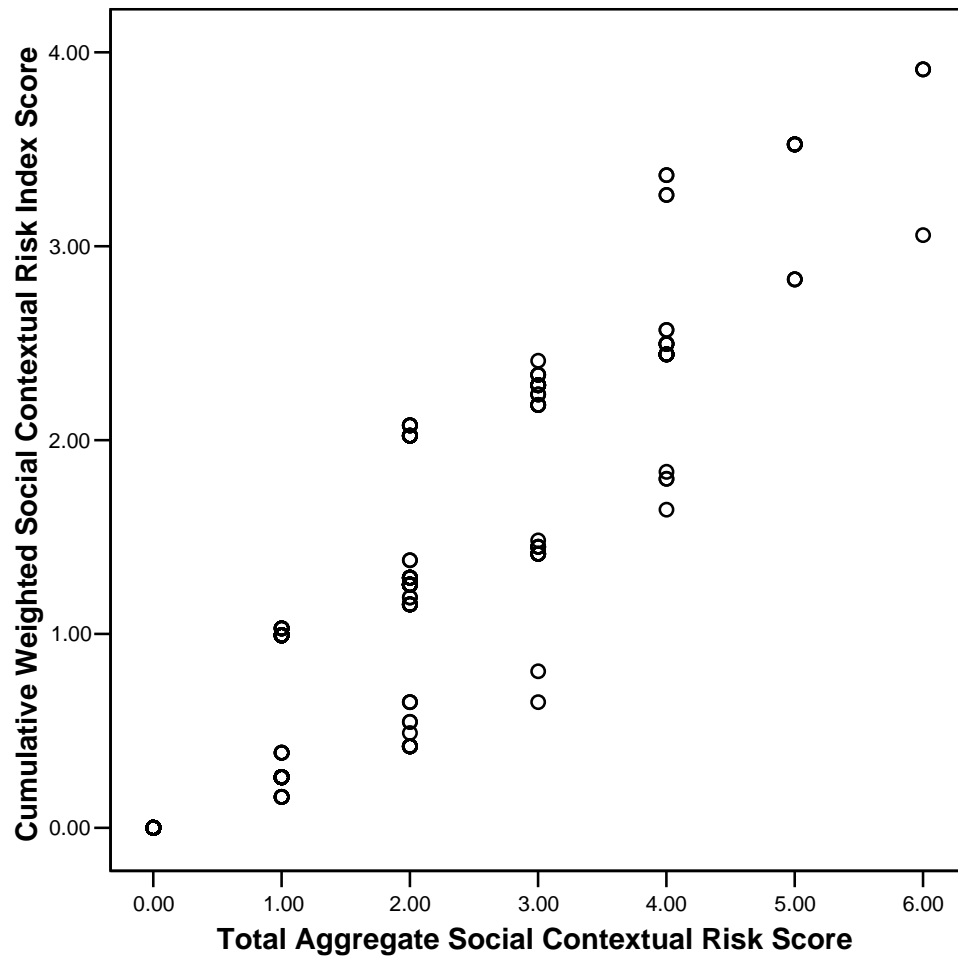


Figure 4. Bivariate scatterplot of weighted risk to aggregate scores.

Figure 4 shows a bivariate scatter plot indicating a strong positive correlation between the Cumulative Weighted Social Contextual Risk Index Scores and the Total Aggregate Social Contextual Risk Score.

Correlation Matrixes

The following correlation matrixes, Tables 17 through 23 present the intercorrelations between various sets of the current study's variables. Table 17 shows the relationship between each of the factors that comprise the Social Contextual Risk Index Score.

Table 17

Correlation Matrix of Covariate Social Contextual Risk Factors

Measure	1	2	3	4	5	6	7
1. Maternal Age	---						
2. Maternal IQ: PPVT-R	.222**	---					
3. Maternal Depression	.169**	.278**	---				
4. Maternal Rating of Social Support	-.018	.019	.123**	---			
5. Low Economic Status	.329**	.391**	.275**	.115**	---		
6. Father Absence	.060	.165**	.090*	.073*	.245**	---	
7. Low Maternal Education	.357**	.348**	.208**	.060	.345**	.106**	---

*p < 0.05. **p < 0.01.

Table 17 demonstrates many statistically significant relationships between the variables which comprise the Social Contextual Risk Index Score. Of the measures making up the Social Contextual Risk Index Score, the two variables that generated the strongest positive correlations with the other variables were Low Economic Status and Low Maternal Education. The two variables that generated the weakest correlations with the other variables were Maternal Ratings of Social Support and Father Absence. Though these results indicate that the covariate measures are significantly correlated it is important to note the correlation levels are low. Thus, issues related to multicollinearity are unlikely.

Table 18 shows the correlational relationship between each of the study's dependent variables.

Table 18

Correlation Matrix of Dependent Effortful Control Variables

Measure					
1. CPT: Omission Errors T-Score - 54 Months	--				
2. CPT: Omission Errors T-Score - Grade 4	.271**	--			
3. CPT: Commission Errors T-Score - 54 Months	.252**	.172**	--		
4. CPT: Commission Errors T-Score - Grade 4	.120**	.384**	.207**	--	
5. CBCL: Maternal Responses to Attention Problems Scale T-Score - 54 Months	.109**	.059	.157**	.093**	--
6. CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4	.124**	.100**	.101**	.120**	.451**

*p < 0.05. **p < 0.01.

The only non-significant correlation expressed in Table 18 is between CBCL Attention Problems T-SCORE at 54 Months and CPT Omission Errors at Grade 4. It is worthy of note that the strongest positive correlations include the relationship between CPT scores given within a single measurement period (e.g., 54 month CPT Omissions to 54 month CPT Commissions), and between the scores generated by a single measure across time (e.g., 54 month CPT Omissions to Grade 4 CPT Omissions). Specifically striking is the strength of the correlation (.451) between the 54 month Maternal Responses to Attention Problems Scale of the CBCL and the Grade 4 Maternal Responses to Attention Problems Scale of the CBCL. These results indicate that the dependant measures are statistically significantly correlated. It is important to note that though the dependant measures are statistically significantly correlated, the correlation levels are generally low. Issues related to multicollinearity are unlikely but will be investigated by an examination of the variance inflation factors.

Table 19 shows the correlational relationship between the individual Social Contextual Risk Factors and the dependent variables.

Table 19

Correlation Matrix of Covariate Social Contextual Risk Factors and Dependent Effortful Control Variables

Effortful Control Variables	Covariate Social Contextual Risk Factors						
	Low Maternal Age	Low Maternal IQ	Maternal Depression	Social Support	Low SES	Father Absence	Low Maternal Education
1. CPT: Omission Errors T-Score - 54 Months	.114**	.121**	.130**	.079*	.220**	.098**	.166**
2. CPT: Omission Errors T-Score - Grade 4	.113**	.177**	.131**	.169**	.171**	.086*	.193**
3. CPT: Commission Errors T-Score - 54 Months	.110**	.080*	.165**	.080*	.191**	.088*	.149**
4. CPT: Commission Errors T-Score - Grade 4	.106**	.246**	.133**	.048	.101**	.063	.170**
5. CBCL: Maternal Responses to Attention Problems Scale T-Score - 54 Months	.141**	.121**	.224**	.069	.164**	.049	.136**
6. CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4	.142**	.128**	.170**	.012	.200**	.028	.172**

* $p < 0.05$. ** $p < 0.01$.

Table 19 demonstrates the social contextual risk factors most correlated to the dependant variables include Low SES, Low Maternal Education, Maternal Depression and to a lesser degree Low Maternal IQ and Low Maternal Age.

Table 20 shows the correlational relationship between the dependant variables, the Weighted Social Contextual Risk Index Score and the independent variable - Attachment security.

Table 20

Correlation Matrix of Dependent Effortful Control Variables, Covariate and Insecure Maternal Attachment

	Dependent Effortful Control Variables					
	CPT: Omission T-SCORE 54 Months	CPT: Omission T-SCORE Grade 4	CPT: Commissions T-SCORE 54 Months	CPT: Commissions T-SCORE Grade 4	Attention Problems T-SCORE 54 Months	Attention Problems T-SCORE Grade 4
Independent Variables						
Weighted Social Contextual Risk Index Score	.209**	.243**	.185**	.248**	.205**	.219**
Insecure Maternal Attachment:	.121**	.114**	.084*	.078*	.131**	.103**
Secure versus Insecure						

*p < 0.05. **p < 0.01.

Table 20 demonstrates that the dependant variables are more strongly and positively correlated with the covariate Weighted Social Contextual Risk Index Score than they are with the independent variable Insecure Maternal Attachment. However, statistically significant relationships exist between each of the displayed variables.

Table 21 shows the intercorrelations between each of the individual social contextual risk factors and the Weighted Social Contextual Risk Index Score with the independent variable Insecure Maternal Attachment.

Table 21

Correlation Matrix of Covariate Social Contextual Risk Factors and Insecure Maternal Attachment

Independent Variable	Covariate Social Contextual Risk Factors							
	Low Maternal Age	Low Maternal Education	Low Maternal IQ	Maternal Depression	Social Support	Low SES	Father Absence	Weighted Social Contextual Risk Index
Insecure Maternal Attachment: Secure versus Insecure	.124**	.124**	.150**	.090*	.041	.075*	.080*	.184**
**p < 0.05. **p < 0.01.								

**p < 0.05. **p < 0.01.

These results show in Table 21 indicate that the intercorrelations between each of the individual social contextual risk factors and the Weighted Social Contextual Risk Index Score with the independent variable Insecure Maternal Attachment are significantly correlated but at a low level. The exception is Maternal Ratings of Social Support which is not significantly correlated to Insecure Maternal Attachment. Issues related to multicollinearity are unlikely but will be investigated by an examination of the variance inflation factors.

Principal Component Analysis

A principal component analysis is presented in Table 22 to identify the principal component structure of various measures generated by the CPT. A principal component analysis is a data reduction procedure used to find meaningful latent or underlying variables from within multilayered data (Stevens, 2002). This analysis was performed using the Statistical Package for the Social Sciences, version 12.0 (SPSS, 2006). The principal component analysis displayed in Table 22 was conducted using Varimax Rotation with Kaiser Normalization (Stevens, 2002) the rotation converged in 3 iterations. The Kaiser Normalization method was utilized so that the number of components with eigenvalues greater than one indicated a factor that should be retained. Finally, as described by Hair, Anderson, Tatham, & Black, (1998) the solution needed to describe a significant amount of variance. The two-component solution shown in Table 22 combined to explain 99.9% of the cumulative variance. A Catell Scree Plot was examined (Figure 5) to look for the point where the line connecting the eigenvalues moves from a vertical line to a horizontal line. The right elbow occurred on the third

component, as such, only two principal components were retained (Catell, 1966).

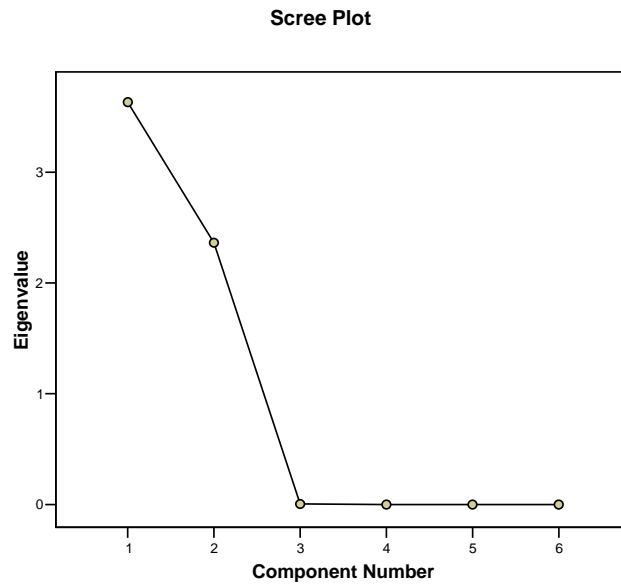


Figure 5. Principal component analysis scree plot.

The principal component analysis provides empirical support for the existing theoretically-based selection of CPT variables to represent attentional control and impulsivity. The CPT was selected as a performance measure of effortful controlled behavior because it provides data indicating attentional control (omission errors) and impulsive, dysinhibited behavior (commission errors) (Epstein et al., 2003).

Table 22

Component Matrix of Measures of the Continuous Performance Test

Continuous Performance Test Scales	Components	
	1 Inattention	2 Impulsivity
CPT: Omission Errors Grade 4	-0.994	0.100
CPT: Proportion Correct Responses Grade 4	0.995	-0.098
CPT: Correct Responses to Critical Stimuli Grade 4	0.995	-0.098
CPT: Total Button Presses Grade 4	0.255	0.967
CPT: Commission Errors Grade 4	-0.290	0.957
CPT: Proportion Incorrect Responses Grade 4	-0.290	0.957

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Note. **Bolded** items indicate that these subscales most strongly loaded onto a particular component, and were considered part of that component.

Table 22 shows a two component solution indicating that the various scores generated by the CPT clearly load onto two distinct components. These various factors have been labeled inattention and impulsivity. The first component, called “Inattention” included

CPT: Omission Errors, CPT: Proportion Correct Responses, and CPT: Correct Responses to Critical Stimuli. The second component, called “Impulsivity” included the *CPT: Total Button Presses, CPT: Commission Errors, and CPT: Proportion Incorrect Responses.*

Because of the strong empirical and theoretical evidence (Epstein et al., 2003; Kochanska, & Murray, 2002; Tracy & Brotman, 2003), *CPT: Omission Errors* and *CPT: Commission Errors* were selected to represent the constructs of Inattention and Impulsivity in the main analyses.

Assumptions and Main Analyses

The following section will restate each research question and the related hypotheses. Results of tests of statistical assumptions related to each of the main analyses are reported as are the results of each of the main analyses.

Research Questions and Hypotheses

Two questions are addressed by this study. The first question concerns the stability of the construct of EC over time. The second research question addresses the central theme of the study; do children of varying levels of maternal attachment security significantly differ in regard to their subsequent formation of EC processes related to attentional control, impulsivity and emotional regulation, after controlling for the effects of social contextual adversity? Hypotheses related to each of these questions were proposed. Results of the tests of the assumptions related to the statistical analyses selected to test each hypothesis are presented, followed by the results of each main analysis. A report of statistical power and effect size are also presented for each main analysis.

Research Question 1

The question: “Does effortfully controlled behavior related to attentional control, impulsivity and emotional regulation as measured by, maternal ratings on the CBCL attention scale and CPT performance, remain stable from 54 months of age to fourth grade?” will be answered by testing four hypotheses. The first two hypotheses related to this question concern the ability of observational and performance data collected in phase II during the 54 month laboratory visit to predict the outcome of observational and performance data collected in phase III during the fourth grade laboratory visit.

Hypothesis #1

Effortfully controlled behaviors related to attentional control, impulsivity and emotional regulation as measured by, maternal ratings on the CBCL attention scale and CPT performance, measured at 54 months of age will predict similar effortfully controlled behaviors measured at fourth grade.

Statistical Analysis

This hypothesis was tested by use of a series of three multiple regressions. Three multiple regressions were necessary because each of the three dependent variables were examined separately. The intention of this analysis was to discover which of the three independent variables entered best predicts the value of each criterion variable (CBCL attention scale rating, CPT Omission performance, or CPT Commission performance at grade 4). The second and third multiple regressions are nearly the same as the first, only the criterion variable is changed. The assumptions are the same for each of the first two hypotheses though tested for each sample analyzed.

Assumptions

Prior to executing the main multiple regression analysis the multiple regression assumptions were tested. Multicollinearity was tested by examining the intercorrelations between the predictor variables, their tolerance values, and their variance inflation factors. Though the predictors are significantly correlated it is important to note the correlation levels are lower than .9. Additionally the predictors' variance inflation factors were all under two and all of the tolerance values were in the .9 range. Tolerance values higher than .6 indicate the assumption of multicollinearity is not violated. Variance inflation factors values under ten indicate the assumption of multicollinearity is not violated. In addition to multicollinearity, multiple regression analyses rely upon four additional assumptions: linearity, normality, independence, and homoscedasticity.

The assumption of normality concerns an expectation of a normal distribution of residuals or error (expected minus observed values) (StatSoft, 2006). Multivariate normality is the assumption that all variables and all combinations of the variables conform to a normal distribution. The assumption of normality was tested by an examination of the dependant variable residuals expected cumulative normal probability plots. Cumulative normal probability plots for each of the dependant variable residuals are displayed in figures 6, 7, and 8.

Dependent Variable: CPT Omissions T score G4

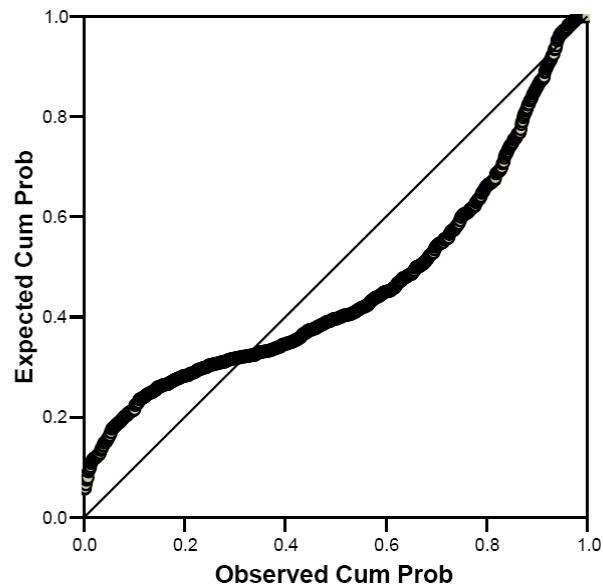


Figure 6. Normal probability plot of the standardized residual of CPT Omission Error T-Scores at fourth grade.

Dependent Variable: CPT Commissions T score G4

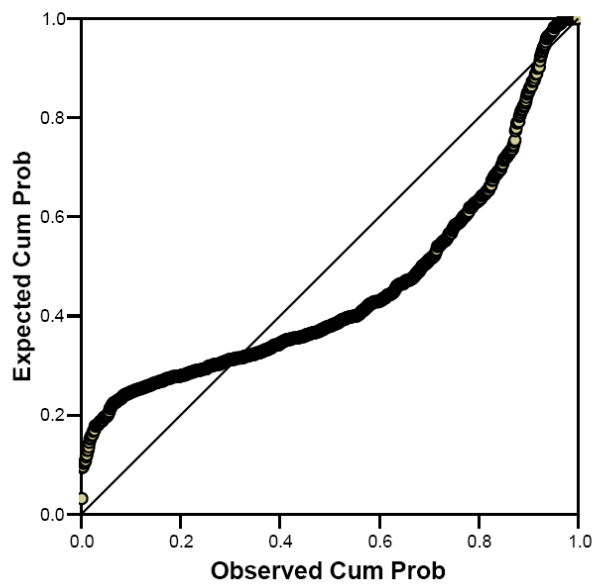


Figure 7. Normal probability plot of the standardized residual of CPT Commission Error T-Scores at fourth grade.

Dependent Variable: CBCL (MOM/ALTCG)-ATTENT PRBS T-
SCORE G4

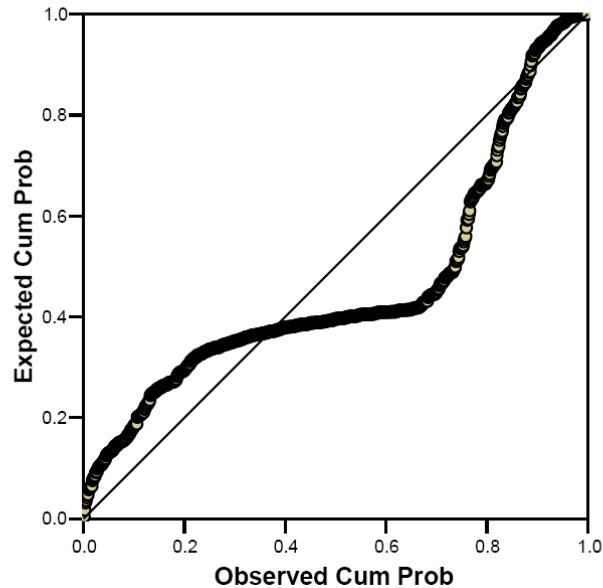


Figure 8. Normal probability plot of the standardized residual of Child Behavior Checklist Attention Problems T-Scores at fourth grade.

The cumulative probability plots of the residuals all fail to conform to a normal distribution. A review of histograms for all of the effortful control variables and histograms of the dependant variable residuals both indicate a nonsymmetrical distribution (see figures 9, 10, and 11). Every variable is positively skewed and leptokurtic, except for omission errors at 54 months which is nether positively skewed nor showing kurtosis. Skewness and kurtosis values are elevated greater than twice the standard error of measurement (Price, 2000). As the variables of interest do not conform to a normal distribution then the assumption of multivariate normality is likely violated. However multiple regression analysis is relatively “robust with regard to violations of this assumption” (StatSoft, 2006, Normality Assumption section, para. 1). Additionally, because of the design of the CPT and the method employed by the NIHCD SECC for recording of CBCL scores a normal distribution was not expected on either measure. The

CPT is designed to detect atypicality. Typical performance involves making no errors or few errors. So the data conform exactly to projected CPT performance. The distribution of the vast majority of CPT scores is skewed towards no errors to few errors. Only atypical subjects performed poorly making many errors, creating a long thin tail. Because it is impossible to score fewer than no errors, typical subjects stacked up along the left side of the distribution creating a positive skew. The CBCL data was coded so that the minimum score was 50. All scale scores lower than 50 were coded as 50 by the NIHCD SECC investigators. As a result, an effect similar to that described impacting the CPT data emerged. CBCL ratings are recorded as T-scores meaning the mean score on any CBCL scale is 50. As all scores below 50 were recoded as 50 a normal distribution is highly unlikely. Because no score can fall below the mean, and only atypical subjects generate high scores, the sample is extremely positively skewed. The data will not be transformed because, though failing to meet the assumption of normality, the data are distributed as expected. An examination of figures 9, 10 and 11 illustrate the positive skew of the CPT and CBCL data.

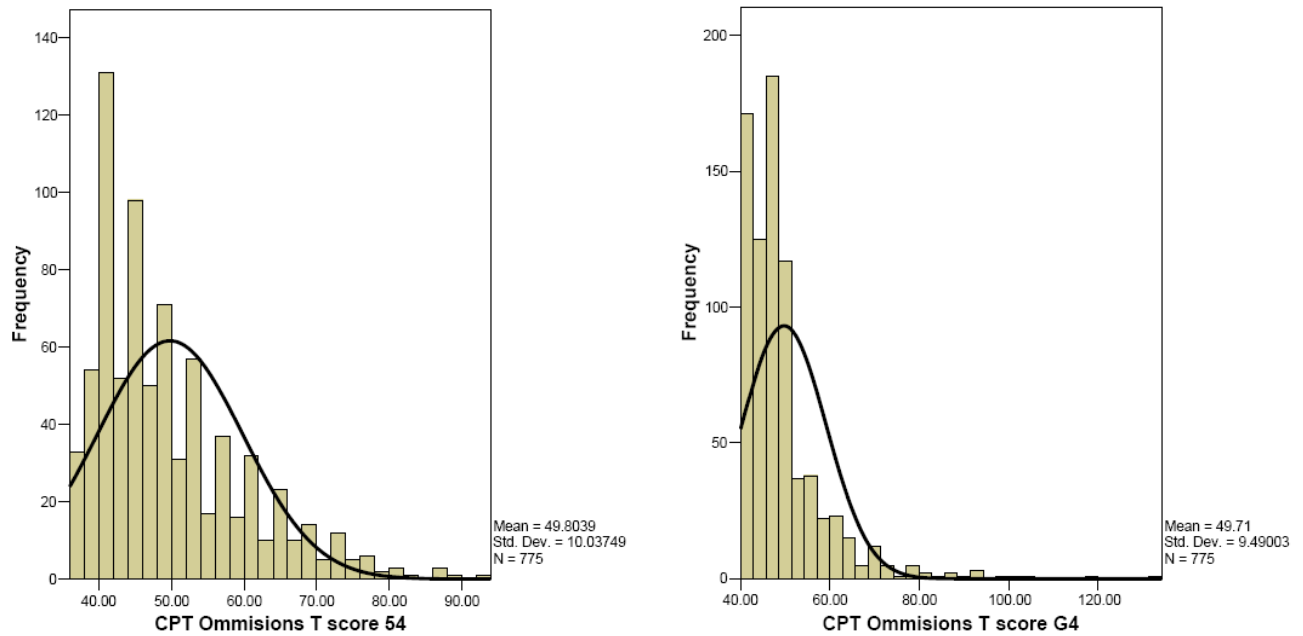


Figure 9. Distribution graphs of Continuous Performance Test Omission T-Scores at 54 months and fourth grade.

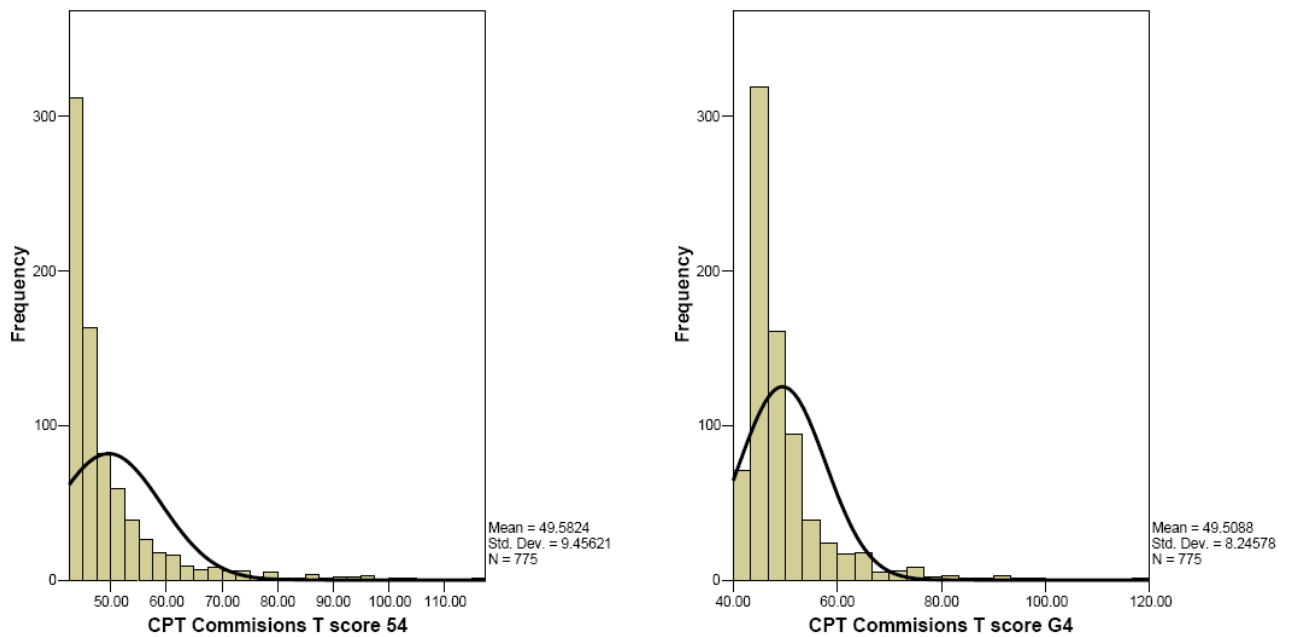


Figure 10. Distribution graphs of Continuous Performance Test Commission Error T-Scores at 54 months and fourth grade.

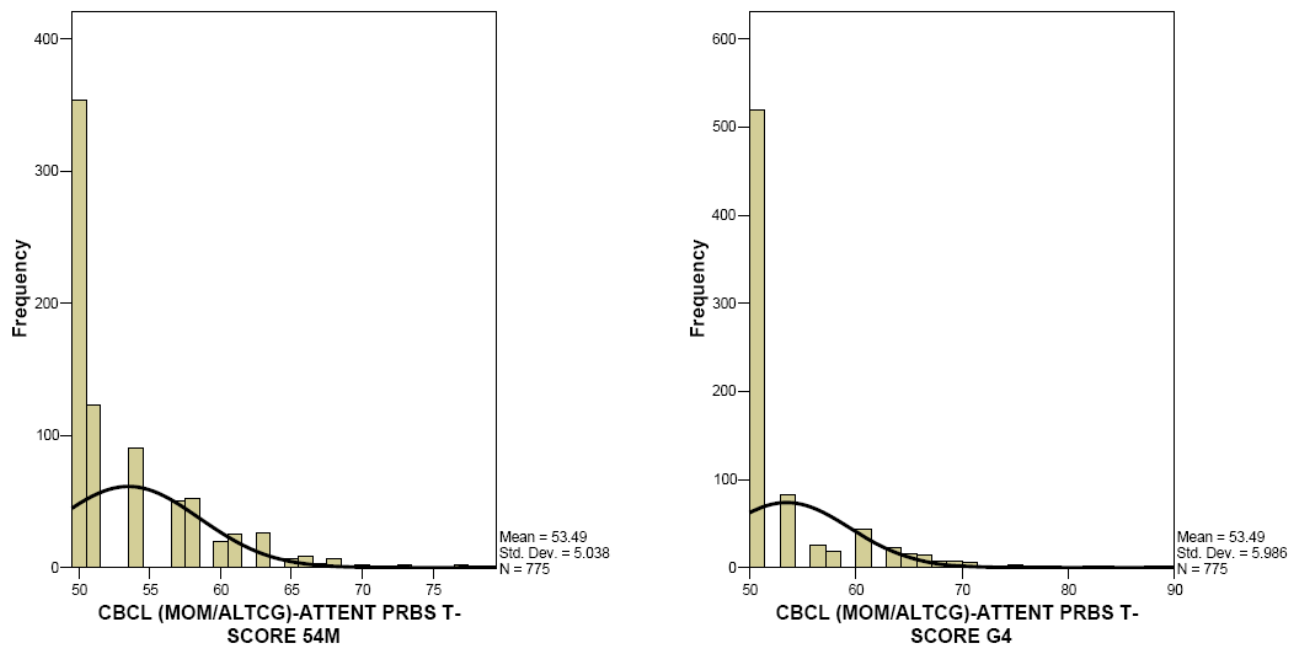


Figure 11. Distribution graphs of Child Behavior Checklist Attention Problems T-Scores at 54 months and fourth grade.

The assumption of linearity was tested by an examination of the bivariate scatterplot of each of the predictors and each criterion (StatSoft, 2006) and by an examination of plots displaying residuals versus the predicted dependent variable (Tabachnick & Fidell 2007). Figure 9 shows each of the bivariate scatterplots for the predictor Omission errors T-Score at 54 months. Figure 10 shows each of the bivariate scatterplots for the predictor Commission Errors T-Score at 54 months. Figure 11 shows each of the bivariate scatterplots for the predictor Child Behavior Checklist Attention Problems T-Scores at 54 months.

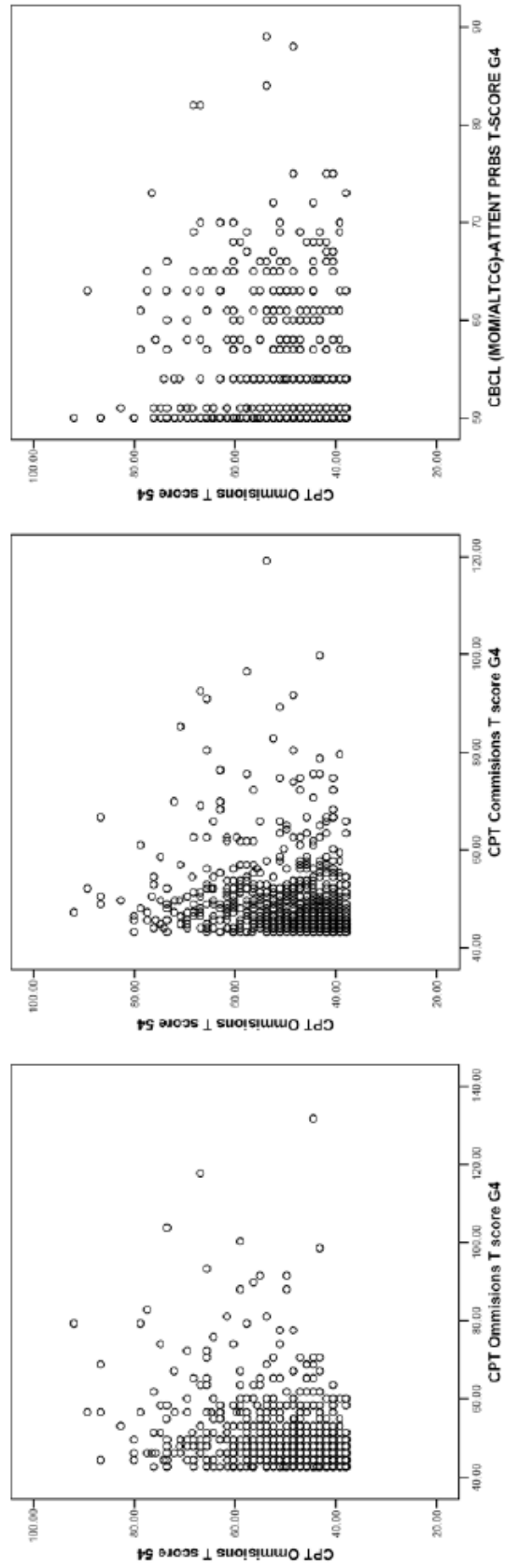


Figure 12. Bivariate scatterplots demonstrating the linear relationship between the predictor Omission Errors T-Scores at 54 months and each criterion variable.

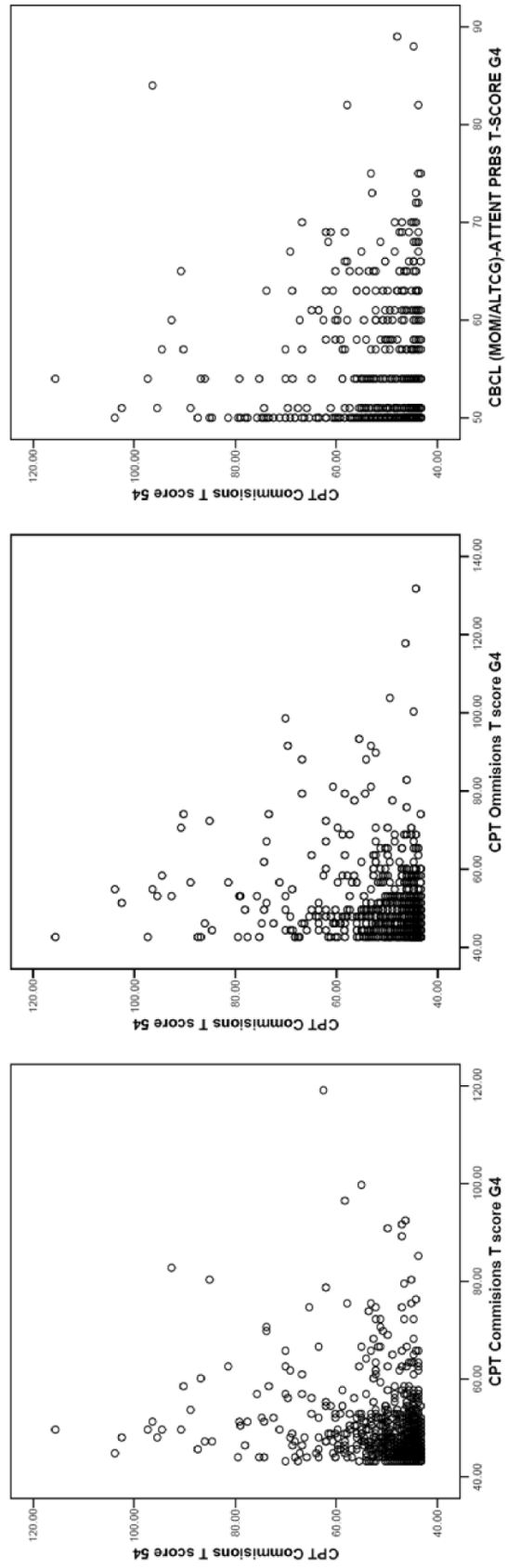


Figure 13. Bivariate scatterplots demonstrating the linear relationship between the predictor Commission errors T-Scores at 54 months and each criterion variable.

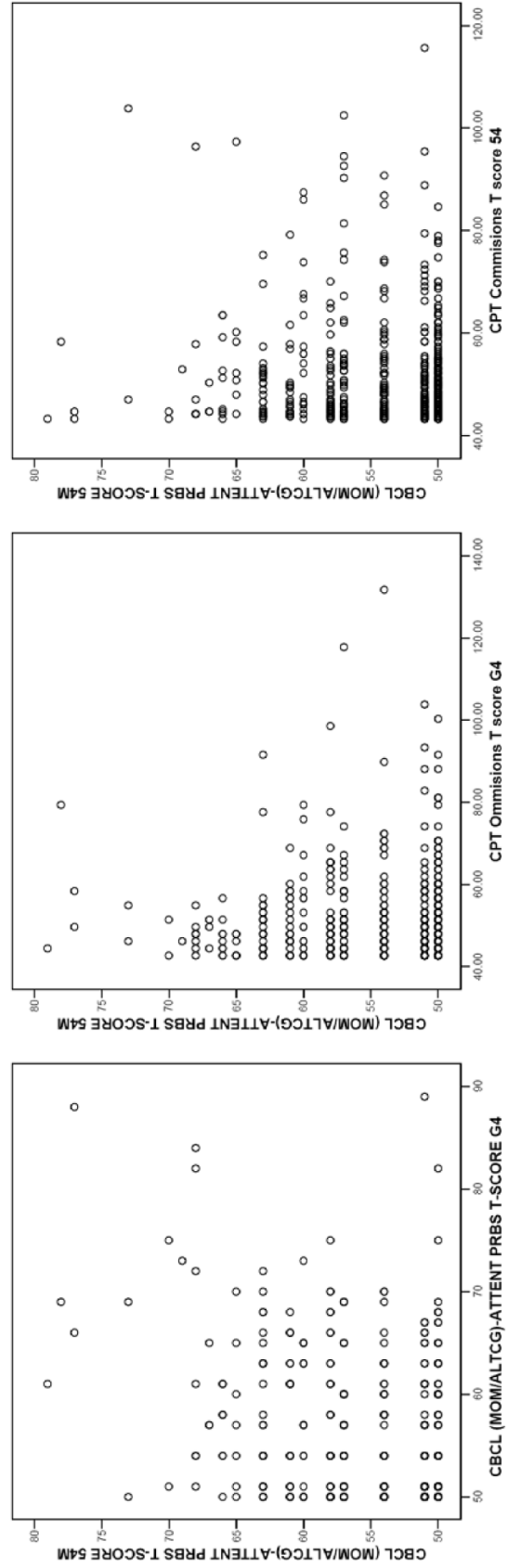


Figure 14. Bivariate scatterplots demonstrating the linear relationship between the predictor Child Behavior Checklist Attention Problems T-Scores at 54 months and each criterion variable.

These scatterplots plots show a good deal of scatter but a linear relationship. Figure 12 shows plots displaying residuals versus the predicted dependent variable.

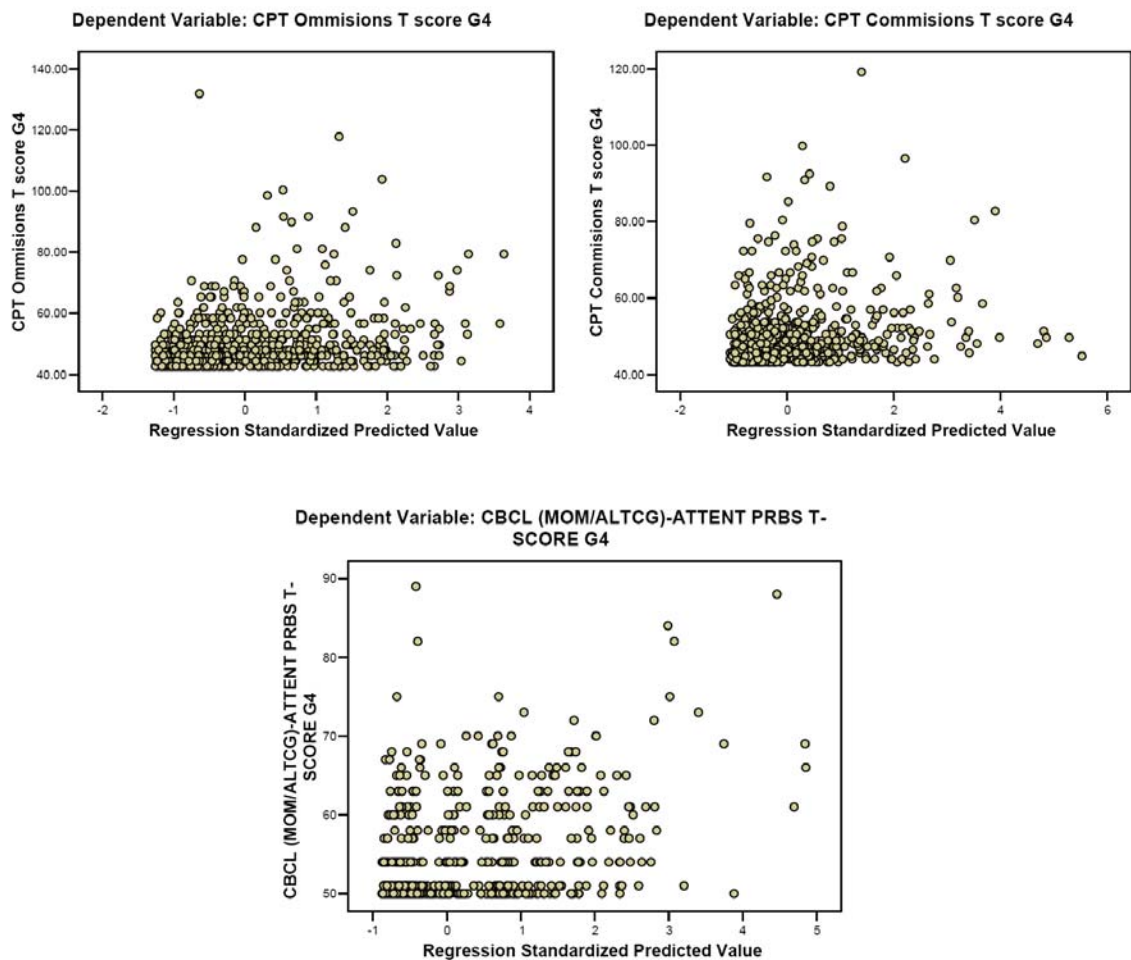


Figure 15. Scatterplots demonstrating residuals versus the predicted dependent variable.

These scatterplots evidenced points scattered randomly around the line originating from the mean of the residuals. This sort of distribution indicates the assumption of linearity is not violated.

The assumption of independence relates to an assumption that errors are independent, meaning that subjects are responding independently of one another (Stevens, 2002). Based upon the design of the study and an examination of the Durbin-Watson statistic for each of the three multiple regression analyses (each criterion variable was independently regressed onto the three predictor variables) the assumption of independence is not

violated. The first of the three multiple regression analyses used fourth grade CPT Omission errors as the criterion variable, producing a Durbin-Watson value of 1.904. The second of the three multiple regression analyses used fourth grade CPT Commission errors as the criterion variable, producing a Durbin-Watson value of 1.938. The third of the three multiple regression analyses used the fourth grade Child Behavior Checklist Attention Problems T-Score as the criterion variable, producing a Durbin-Watson value of 1.952. The Durbin-Watson statistic calculates the autocorrelation of errors over all cases; values between 1.5 and 2.5 suggest independence (Tabachnick & Fidell, 2007).

The assumption of homoscedasticity assumes the variance of residuals is spread consistently around the regression line (the same across all levels of the predictor), so the variance of errors across all values of the predictors is constant. When the converse is found (variance of errors differing at different values of the predictor), heteroscedasticity is indicated. Homoscedasticity was evaluated by examining residual scatter plots (plots of the standardized residuals against predicted scores) (Stevens, 2002). Results of an examination of the residual scatter plots indicate moderate heteroscedasticity (See figure 15). The extent of this violation of the assumption of homoscedasticity mildly elevates the risk of a Type I error weakening rather than invalidating the regression. However, the sample size is sufficiently large so that regression analysis is robust to this violation (Stevens, 2002; Tabachnick & Fidell 2007).

Each criterion variable was independently regressed onto the three predictor variables. Results of each regression analysis are presented in Tables 18-20.

The first regression analysis of the first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors

at 54 months, and CPT Commission at 54 months and the criterion variable CPT Omission errors at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 23.

Table 23

Stepwise Regression Analysis Summary for 54 Month Effortful Control Variables

Predicting Fourth Grade CPT Omission Errors

Model	B	SEB	B	T	Sig.
2					
CPT: Omission Errors T-Score 54 Months	.230	.034	.243	6.827	.000
CPT: Commission Errors T-Score 54 Months	.112	.036	.111	3.128	.002
Excluded IV					
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months				.430	.668

Note. Predictors in the Model: (Constant), CPT: Omission Errors T-Score 54 Months, CPT: Commission Errors T-Score 54 Months.

Dependent Variable: CPT: Omission Errors T-Score at Fourth Grade.

$R^2 = .085$, $F(2,772) = 35.86$, $p < .001$.

The first stepwise regression analysis for the first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CPT Omission errors at grade 4. The stepwise regression analysis indicates the most variance is accounted for by Model 2. Model 2 includes the predictor variables CPT Omission errors at 54 months, and CPT Commission at 54 months. Model 2 excluded the variable CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months. The 54 month CBCL: Maternal Responses to Attention Problems Scale T-Score was removed due to a non-significant contribution to the variance of Fourth Grade CPT: Omission Errors T-Scores. Model 2 explains 8.5% of the variance in Fourth Grade CPT: Omission Errors T-Scores. Results indicate Model 2 significantly predicts Fourth Grade CPT: Omission Errors T-Scores ($F(2,772) = 35.86, p < .001$). As expected Omission and Commission CPT Scores from the 54 month laboratory visit significantly predict Fourth Grade CPT Omission Scores.

The second regression analysis of the first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CPT Commission errors at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 24.

Table 24

*Stepwise Regression Analysis Summary for 54 Month Effortful Control Variables**Predicting Fourth Grade CPT Commission Errors*

Model	B	SEB	B	T	Sig.
2					
CPT: Commission Errors T-Score 54 Months	.164	.032	.188	5.189	.000
CPT: Omission Errors T-Score 54 Months	.060	.030	.073	2.004	.045
Excluded IV					
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months				.110	.057

Note. Predictors in the Model: (Constant), CPT: Commission Errors T-Score 54 Months, CPT: Omission Errors T-Score 54 Months.

Dependent Variable: CPT: Commission Errors T-Score at Fourth Grade.

$R^2 = .048$, $F(2,772) = 19.315$, $p < .001$.

The second stepwise regression analysis for the first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CPT Commission errors at grade 4. The stepwise regression analysis indicates the most variance is accounted for by Model 2. Model 2 includes the predictor variables

CPT Omission errors at 54 months, and CPT Commission at 54 months. Model 2 excluded the variable CBCL: Maternal Responses to Attention Problems Scale T-Score 54. Months. The 54 month CBCL: Maternal Responses to Attention Problems Scale T-Score was removed due to a non-significant contribution to the variance of Fourth Grade CPT: Commission Errors T-Scores. Model 2 explains 4.8% of the variance in Fourth Grade CPT: Commission Errors T-Scores. Results indicate Model 2 significantly predicts Fourth Grade CPT: Commission Errors T-Scores ($F(2,772) = 19.315, p < .001$). As expected Omission and Commission CPT Scores from the 54 month laboratory visit significantly predict Fourth Grade CPT Commission Scores.

The third regression analysis of the first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CBCL attention scale rating at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 25.

Table 25

*Stepwise Regression Analysis Summary for 54 Month Effortful Control Variables**Predicting Fourth Grade CBCL Attention Scale*

Model	B	SEB	B	T	Sig.
2					
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months	.526	.038	.443	13.756	.000
CPT: Omission Errors T-Score 54 Months	.045	.019	.076	2.356	.019
Excluded IV					
CPT: Commission Errors T-Score 54 Months				.412	.680

Note. Predictors in the Model: (Constant), CBCL: Maternal Responses to Attention Problems Scale at 54 Months, CPT: Omission Errors T-Score 54 Months.

Dependent Variable: CBCL: Maternal Responses to Attention Problems Scale at Fourth Grade.

$R^2 = .209$, $F(2,772) = 102.133$, $p < .001$.

The third stepwise regression analysis for the first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CBCL attention scale rating at grade 4. The stepwise regression analysis indicates the most variance is accounted for by Model 2. Model 2 includes the predictor

variables CBCL: Maternal Responses to Attention Problems Scale T-Score 54 and CPT Omission errors at 54 months. Model 2 excluded the variable CPT Commission errors at 54 Months. The CPT Commission error score at 54 Months was removed due to a non-significant contribution to the variance of Fourth Grade CBCL: Maternal Responses to Attention Problems Scale. Model 2 explains 20.9% of the variance in Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores. Results indicate Model 2 significantly predicts Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores ($F(2,772) = 102.133, p < .001$). As expected 54 Month CBCL: Maternal Responses to Attention Problems Scale T-Scores significantly predict Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores. Unexpectedly CPT Omission errors from the 54 month laboratory visit also contributed significant variance to predicting Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores.

Hypothesis #2

Effortfully controlled behaviors related to attentional control, impulsivity and emotional regulation as measured by, maternal ratings on the CBCL attention scale and CPT performance, at 54 months of age will predict similar effortfully controlled behaviors measured at fourth grade for boys and girls studied separately.

Statistical Analysis

Testing the second hypothesis necessitated a series of six multiple regressions (two sets of three multiple regressions). Two sets of multiple regressions (one set for the samples boys and one set for the samples girls) were required to discover which of the three independent variables entered best predicts the value of each criterion variable

(CBCL attention scale rating, CPT Omission performance, or CPT Commission performance at grade 4) when analyzing the sample's boys and girls separately.

Analysis of the Sample's Boys and Girls Assumptions Tested Separately

Prior to executing the main multiple regression analyses the multiple regression assumptions for the sample's boys and girls were tested separately. Multicollinearity was tested by examining the intercorrelations between the predictor variables and their variance inflation factors. Table 26 shows the correlation matrix of the sample's boys. Table 27 shows the correlation matrix of the sample's girls.

Table 26

Summary Correlation Matrix of Boy's Dependent Effortful Control Variables

Measure	1	2	3	4	5	6
1. CPT: Omission Errors T-Score - 54 Months	---					
2. CPT: Omission Errors T-Score - Grade 4	.337**	---				
3. CPT: Commission Errors T-Score - 54 Months	.191**	.145**	---			
4. CPT: Commission Errors T-Score - Grade 4	.106**	.432**	.135**	---		
5. CBCL: Maternal Responses to Attention Problems Scale T-Score - 54 Months	.118**	.073	.202**	.182**	---	
6. CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4	.082**	.085	.042	.151**	.380**	---

* $p < 0.05$. ** $p < 0.01$.

Table 27

Summary Correlation Matrix of Girl's Dependent Effortful Control Variables

Measure	1	2	3	4	5	6
1. CPT: Omission Errors T-Score - 54 Months	---					
2. CPT: Omission Errors T-Score - Grade 4	.173**	---				
3. CPT: Commission Errors T-Score - 54 Months	.353**	.188**	---			
4. CPT: Commission Errors T-Score - Grade 4	.101*	.279**	.200**	---		
5. CBCL: Maternal Responses to Attention Problems Scale T-Score - 54 Months	.117*	.062	.184**	.051	---	
6. CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4	.168**	.118*	.216**	.151**	.508**	---

* $p < 0.05$. ** $p < 0.01$.

A separate examination of the sample's boys and girls shows that in both cases the predictors are significantly correlated but it is important to note, the correlation levels are low. Additionally the boy's and girls' predictors' variance inflation factors were all under two. Values under ten indicate the assumption of multicollinearity is not violated. Based upon the low correlations between the predictors and the low variance inflation factors the assumption of multicollinearity is not violated in either the boy's or girl's sample.

In addition to multicollinearity, multiple regression analyses rely upon four additional assumptions: linearity, normality, independence, and homoscedasticity. The assumption of normality concerns an expectation of a normal distribution of residuals or error

(expected minus observed values) (StatSoft, 2006). Multivariate normality is the assumption that all variables and all combinations of the variables conform to a normal distribution. The assumption of normality was tested by a separate examination of the sample's boys' and girls' cumulative normal probability plots. These plots roughly conform to the same distribution displayed in Figures 6, 7 and 8 which show the cumulative normal probability plots of all subjects together. The cumulative probability plots of the residuals fail to conform to a normal distribution in both the sample's boys and girls. A separate examination of the sample's boys' and girls' histograms for all of the effortful control variables and histograms of the dependant variable residuals both indicate a nonsymmetrical distribution in every variable for both samples. Every variable is positively skewed and leptokurtic, except omission errors at 54 months (for both boys and girls) is neither positively skewed or showing kurtosis. Skewness and Kurtosis values are elevated greater than twice the standard error of measurement (Price, 2000). As the variables of interest do not conform to a normal distribution then the assumption of multivariate normality is likely violated. These histograms roughly conform to the same distribution displayed in figures 9, 10 and 11 of all subjects together. However multiple regression analysis is relatively "robust with regard to violations of this assumption" (StatSoft, 2006, Normality Assumption section, para. 1). Additionally, because of the design of the CPT and the method employed by the NIHCD SECC for recording of CBCL scores a normal distribution was not expected on either measure. The CPT is designed to detect atypicality. Typical performance involves making no errors or few errors. So the data conform exactly to projected CPT performance. The distribution of the vast majority of CPT scores is skewed towards no errors to few errors. Only atypical

subjects performed poorly making many errors, creating a long thin tail. Because it is impossible to score fewer than no errors, typical subjects stacked up along the left side of the distribution creating a positive skew. The CBCL data was coded so that the minimum score was 50. All scale scores lower than 50 were coded as 50 by the NIHCD SECC investigators. As a result an effect similar to that described impacting the CPT data emerged. CBCL ratings are recorded as T-scores meaning the mean score on any CBCL scale is 50. As all scores below 50 were recoded as 50 a normal distribution is highly unlikely. Because no score can fall below the mean, and only atypical subjects generate high scores, the sample is extremely positively skewed. The data will not be transformed because though failing to meet the assumption of normality the data are distributed as expected.

The assumption of linearity was tested by a separate examination of the boys' and girls' bivariate scatterplots for each of the predictors and each criterion (StatSoft, 2006) and by an examination of plots displaying residuals versus the predicted dependent variable (Tabachnick & Fidell 2007). The bivariate scatterplot of each of the predictors and each criterion show a good deal of scatter but a linear relationship. These plots are similar to the bivariate scatterplot of each of the predictors and each criterion for all subject together shown in Figures 12, 13 and 14. The plots displaying residuals versus the predicted dependent variable evidenced points scattered randomly around the line originating from the mean of the residuals these plots indicate the assumption of linearity is not violated. The scatterplots displaying boys' and girls' residuals versus the predicted dependent variable roughly conform to the same distribution displayed in Figure 15 of all subjects together.

The assumption of independence relates to an assumption that errors are independent, meaning that subjects are responding independently of one another (Stevens, 2002).

Based upon the design of the study and an examination of the Durbin-Watson statistic for each of the three multiple regression analyses of the sample's boys and girls studied separately, the assumption of independence is determined not to be violated.

The first of the three multiple regression analyses used fourth grade CPT Omission errors as the criterion variable, producing a Durbin-Watson value for boys of 1.925 and a Durbin-Watson value for girls of 1.943. The second of the three multiple regression analyses used fourth grade CPT Commission errors as the criterion variable, producing a Durbin-Watson value for boys of 1.833 and a Durbin-Watson value for girls of 1.697.

The third of the three multiple regression analyses used the fourth grade Child Behavior Checklist Attention Problems T-Score as the criterion variable, producing a Durbin-Watson value of for boys of 1.934 and a Durbin-Watson value for girls of 1.986. The Durbin-Watson statistic calculates the autocorrelation of errors over all cases; values between 1.5 and 2.5 suggest independence (Tabachnick & Fidell, 2007).

The assumption of homoscedasticity assumes the variance of residuals is spread consistently around the regression line (the same across all levels of the predictor), so the variance of errors across all values of the predictors is constant. When the converse is found (variance of errors differing at different values of the predictor), heteroscedasticity is indicated. Homoscedasticity was evaluated by separately examining residual scatter plots (plots of the standardized residuals) (Stevens, 2002) of the sample's boys and girls. Results of an examination of the residual scatter plots indicate moderate heteroscedasticity. The residual scatter plots of the sample's boys and girls are roughly

the same as residual scatter plots of all subject together (see Figure 15.). The extent of this violation of the assumption of homoscedasticity mildly elevates the risk of a Type I error weakening rather than invalidating the regression. However, the sample size is sufficiently large (even when considering boys and girls separately) so that regression analysis is robust to this violation (Stevens, 2002; Tabachnick & Fidell 2007).

Boys.

First the sample's boys were examined. Each criterion variable was independently regressed onto the three predictor variables. Results of each regression analysis are presented in Tables 28-30.

The first regression analysis of the sample's boys for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CPT Omission errors at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 28.

Table 28

*Boys Only Stepwise Regression Analysis Summary for 54 Month Effortful Control**Variables Predicting Fourth Grade CPT Omission Errors*

Model	B	SEB	B	t	Sig.
1					
CPT: Omission Errors T-Score 54 Months	.328	.047	.337	6.925	.000
Excluded IV					
CPT: Commission Errors T-Score 54 Months				1.694	.091
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months				.682	.496

Note. Predictors in the Model: (Constant), CPT: Omission Errors T-Score 54 Months.

Dependent Variable: CPT: Omission Errors T-Score at Fourth Grade.

$R^2 = .114$, $F(1,374) = 47.957$, $p < .001$.

The first regression analysis of the sample's boys for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CPT Omission errors at grade 4. The stepwise regression analysis indicates the most variance is accounted for by Model 1. Model 1 includes the predictor variable CPT Omission errors at 54 months. Model 1 excluded the variables CPT

Commission errors at 54 months and CBCL: Maternal Responses to Attention Problems Scale T-Score 54 months. The 54 month CBCL: Maternal Responses to Attention Problems Scale T-Score and 54 month CPT Commission errors were removed due to a non-significant contribution to the variance of Fourth Grade CPT: Omission Errors T-Scores. Model 1 explains 11.4% of the variance in Fourth Grade CPT: Omission Errors T-Scores. Results indicate Model 1 significantly predicts Fourth Grade CPT: Omission Errors T-Scores ($F(1,374) = 47.957, p < .001$). As expected Omission CPT Scores from the 54 month laboratory visit significantly predict Fourth Grade CPT Omission Scores.

The second regression analysis of the sample's boys for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CPT Commission errors at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 29.

Table 29

*Boys Only Stepwise Regression Analysis Summary for 54 Month Effortful Control**Variables Predicting Fourth Grade CPT Commission Errors*

Model	B	SEB	β	t	Sig.
2					
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months	.339	.109	.161	3.115	.002
CPT: Commission Errors T-Score 54 Months	.087	.044	.103	1.987	.048
Excluded IV					
CPT: Omission Errors T-Score 54 Months				1.371	.171

Note. Predictors in the Model: (Constant), CBCL: Maternal Responses to Attention

Problems Scale T-Score 54 Months, CPT: Commission Errors T-Score 54 Months.

Dependent Variable: CPT: Commission Errors T-Score at Fourth Grade.

$R^2 = .043$, $F(2,373) = 8.414$, $p < .001$.

The second regression analysis of the sample's boys for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CPT Commission errors at grade 4. The stepwise regression analysis

indicates the most variance is accounted for by Model 2. Model 2 includes the predictor variables CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months and CPT Commission errors at 54 months. Model 2 excluded the variable CPT Omission errors at 54 months. The 54 month CPT Omission errors was removed due to a non-significant contribution to the variance of Fourth Grade CPT: Commission Errors T-Scores. Model 2 explains 4.3% of the variance in Fourth Grade CPT: Commission Errors T-Scores. Results indicate Model 2 significantly predicts Fourth Grade CPT: Commission Errors T-Scores ($F(2,373) = 8.414, p < .001$). CBCL: Maternal Responses to Attention Problems Scale T-Score at 54 Months and CPT Commission error scores from the 54 month laboratory visit significantly predict Fourth Grade CPT Commission error scores. Bonferroni correction was not employed because such an adjustment would produce an overly conservative result. Only three regressions were executed and the use of Bonferroni's correction would restrict the probability of finding significance leading to too great a likelihood of Type II error.

The third regression analysis of the sample's boys for the first research question's second hypothesis examined CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CBCL attention scale rating at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 30.

Table 30

*Boys Only Stepwise Regression Analysis Summary for 54 Month Effortful Control**Variables Predicting Fourth Grade CBCL attention scale*

Model	B	SEB	β	t	Sig.
1					
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months Excluded IV	.478	.060	.380	7.955	.000
CPT: Omission Errors T-Score 54 Months				.792	.429
CPT: Commission Errors T-Score 54 Months				-.741	.459

Note. Predictors in the Model: (Constant), CBCL: Maternal Responses to Attention Problems Scale at 54 Months.

Dependent Variable: CBCL: Maternal Responses to Attention Problems Scale at Grade 4.

$R^2 = .145$, $F(1,374) = 63.283$, $p < .001$.

The third stepwise regression analysis of the sample's boys first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CBCL attention scale rating at grade 4. The stepwise regression analysis indicates the most variance is accounted for by Model 1. Model 1 includes the

predictor variable CBCL: Maternal Responses to Attention Problems Scale T-Score 54. Model 1 excluded the variables CPT Omission errors at 54 months and CPT Commission errors at 54 Months. The CPT Omission and Commission error scores at 54 Months were removed due to a non-significant contribution to the variance of Fourth Grade CBCL: Maternal Responses to Attention Problems Scale. Model 1 explains 14.5% of the variance in Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores. Results indicate Model 1 significantly predicts Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores ($F(1,374) = 63.283, p < .001$). As expected 54 Month CBCL: Maternal Responses to Attention Problems Scale T-Scores significantly predict Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores.

Girls.

The sample's girls were examined. Each criterion variable was independently regressed onto the three predictor variables. Results of each regression analysis are presented in Tables 31-33.

The first regression analysis of the sample's girls for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CPT Omission errors at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 31.

Table 31

*Girls Only Stepwise Regression Analysis Summary for 54 Month Effortful Control**Variables Predicting Fourth Grade CPT Omission Errors*

Model	B	SEB	β	t	Sig.
2					
CPT: Commission Errors T-Score 54 Months	.194	.070	.145	2.77	.006
CPT: Omission Errors T-Score 54 Months	.110	.048	.121	2.318	.021
Excluded IV CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months				.431	.667

Note. Predictors in the Model: (Constant), CPT: Commission Errors T-Score 54 Months, CPT: Omission Errors T-Score 54 Months.

Dependent Variable: CPT: Omission Errors T-Score at Fourth Grade.

$R^2 = .048$, $F(2,396) = 10.065$, $p < .001$.

The first regression analysis of the sample's girls for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CPT Omission errors at grade 4. The stepwise regression analysis

indicates the most variance is accounted for by Model 2. Model 2 includes the predictor variables CPT Commission errors at 54 months and CPT Omission errors at 54 months. Model 2 excluded the variable CBCL: Maternal Responses to Attention Problems Scale T-Score 54 months. The 54 month CBCL: Maternal Responses to Attention Problems Scale T-Score was removed due to a non-significant contribution to the variance of Fourth Grade CPT: Omission Errors T-Scores. Model 2 explains 4.8% of the variance in Fourth Grade CPT: Omission Errors T-Scores. Results indicate Model 2 significantly predicts Fourth Grade CPT: Omission Errors T-Scores ($F(2,396) = 10.065, p < .001$). CPT Omission and Commission Error Scores from the 54 month laboratory visit significantly predict Fourth Grade CPT Omission Scores.

The second regression analysis of the sample's girls for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CPT Commission errors at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 32.

Table 32

*Girls Only Stepwise Regression Analysis Summary for 54 Month Effortful Control**Variables Predicting Fourth Grade CPT Commission Errors*

Model	B	SEB	β	t	Sig.
1					
CPT: Commission Errors T-Score 54 Months	.183	.045	.200	4.076	.000
Excluded IV					
CPT: Omission Errors T-Score 54 Months				.665	.506
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months				.290	.772

Note. Predictors in the Model: (Constant), CPT: Commission Errors T-Score 54 Months.

Dependent Variable: CPT: Commission Errors T-Score at Fourth Grade.

$R^2 = .040$, $F(1,397) = 16.617$, $p < .001$.

The second regression analysis of the sample's girls for the first research question's second hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CPT Commission errors at grade 4. The stepwise regression analysis indicates the most variance is accounted for by Model 1. Model 1 includes the predictor variable: CPT Commission errors at 54 months. Model 1 excluded the variables: CPT

Omission errors at 54 months and CBCL: Maternal Responses to Attention Problems Scale T-Score at 54 Months. The 54 month CPT Omission errors and CBCL: Maternal Responses to Attention Problems Scale T-Score at 54 Months were removed due to a non-significant contribution to the variance of Fourth Grade CPT: Commission Errors T-Scores. Model 1 explains 4.0% of the variance in Fourth Grade CPT: Commission Errors T-Scores. Results indicate Model 1 significantly predicts Fourth Grade CPT: Commission Errors T-Scores ($F(1,397) = 16.617, p < .001$). CPT Commission error scores from the 54 month laboratory visit significantly predict Fourth Grade CPT Commission error scores.

The third regression analysis of the sample's girls for the first research question's second hypothesis examined CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable CBCL attention scale rating at grade 4. To discover the relative predictive power of each of the three predictor variables, stepwise analyses procedures were used. Results are presented in Table 33.

Table 33

*Girls Only Stepwise Regression Analysis Summary for 54 Month Effortful Control**Variables Predicting Fourth Grade CBCL attention scale*

Model	B	SEB	β	t	Sig.
2					
CBCL: Maternal Responses to Attention Problems Scale T-Score 54 Months	.555	.050	.485	11.123	.000
CPT: Commission Errors T-Score 54 Months	.123	.042	.127	.2922	.004
Excluded IV					
CPT: Omission Errors T-Score 54 Months				1.665	.097

Note. Predictors in the Model: (Constant), CBCL: Maternal Responses to Attention Problems Scale at 54 Months, CPT: Commission Errors T-Score 54 Months.

Dependent Variable: CBCL: Maternal Responses to Attention Problems Scale at Grade 4.

$R^2 = .274$, $F(2,396) = 74.616$, $p < .001$.

The third stepwise regression analysis of the sample's girls first research question's first hypothesis examined the predictor variables: CBCL attention scale rating at 54 months, CPT Omission errors at 54 months, and CPT Commission at 54 months and the criterion variable: CBCL attention scale rating at grade 4. The stepwise regression analysis indicates the most variance is accounted for by Model 2. Model 2 includes the

predictor variables: CBCL: Maternal Responses to Attention Problems Scale T-Score 54 and CPT: Commission Errors T-Score 54 Months. Model 2 excluded the variables CPT Omission errors at 54 months. The CPT Omission error scores at 54 Months were removed due to a non-significant contribution to the variance of Fourth Grade CBCL: Maternal Responses to Attention Problems Scale. Model 2 explains 27.4% of the variance in Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores. Results indicate Model 2 significantly predicts Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores ($F(2,396) = 74.616$). Fifty four month CBCL: Maternal Responses to Attention Problems Scale T-Scores and Commission Errors T-Score at 54 Months significantly predict Fourth Grade CBCL: Maternal Responses to Attention Problems Scale T-Scores.

Hypothesis #3

The study's participating children will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by, maternal ratings on the CBCL attention scale and CPT performance.

Statistical Analysis

Hypotheses #3 was tested with a one way, two level Multivariate Analyses of Variance (MANOVA) to determine if the study's participating children do not exhibit statistically significant differences between normatively-derived levels of effortfully controlled behavior at 54 months and fourth grade. Time served as the independent variable (the grouping variable) and measures of effortfully controlled behavior (CBCL

attention scale T scores, CPT Omission Errors T scores and CPT Commission Errors T scores) as the dependent variable. Measures of effortfully controlled behavior were collected at 54 months and again when the participants were in fourth grade.

Assumptions

MANOVA rely upon five assumptions: multicollinearity, independence, linearity, normality, and homogeneity of variance-covariance. Tests of the assumptions of multicollinearity, independence, linearity, and normality were described above. The assumptions of homogeneity of variance-covariance matrices was examined for robustness using the Box's M test. The Box's M test is significant when the variance across dependent measures differs. The Box's M test is also sensitive to violations of the assumption of multivariate normality (Tabachnick & Fidell, 2007). Results of the Box's M test indicate a violation of the assumption of homogeneity of variance-covariance. This violation suggests that the covariance matrices are too dissimilar to entirely rely upon use of the Wilks' Lambda statistic (Stevens, 2002). It also indicates as reported above that the assumption of multivariate normality is violated. Both the Pillai's Trace and the Wilks' Lambda statistics will be reported. The Wilks' lambda will be reported because it is the most commonly reported (Tabachnick & Fidell, 2007) and the Pillai's Trace statistic is reported because it is the most robust to the violation of homogeneity of variance-covariance.

Table 34 shows a one way, two level MANOVA. The intention of the MANOVA is to determine if the study's participating children exhibit no difference between normatively-derived levels of effortfully controlled behavior at time 1 (54 months) and time 2 (Grade 4). In this way the stability over time of the construct of effortful control

can be measured. The MANOVA compares the vector of population means for time 1 (54 months) and time 2 (Grade 4) on the measures of effortfully controlled behavior. Time is used as the grouping (independent) variable and the combined variance of the three dependant measures of effortfully controlled behavior (CBCL: Attention Scale T scores, CPT Omission Errors T scores and CPT Commission Errors T scores) serves as the dependent variable.

Table 34

Summary MANOVA Table Comparing Effortful Control Performance at 54 Months to Effortful Control Performance at Grade 4.

<u>Independent Variable:</u>	Effortful Control MANOVA				
	<i>Df</i>	<i>F</i>	<i>Sig.</i>	<i>Effect size</i>	<i>Observed Power^a</i>
Time	1,774	.016	.997	.000	.053

Note. MANOVA = multivariate analysis of variance

a: Computed using alpha = .05

As hypothesed, results of the MANOVA analysis using both the Wilk's criterion and the Pillai's Trace statistic, failed to show significant difference between the vector of population means for time 1 (54 months) and time 2 (Grade 4) on the measures of effortfully controlled behavior ($F(1, 774) = .016, p = .997$), with a Wilks' Lambda value of 1.0 and a Pillai's Trace value of 0.000. Table 12 presents complete descriptive statistics of the summary distribution of mean, standard deviation, and range for each dependant variable measure of effortful control including raw scores and T scores of the

CPT data. The raw difference between the mean CPT omission errors T-score for children for time 1 (54 months) and time 2 (Grade 4) is .09. The raw difference between the mean CPT commission errors T-score for children for time 1 (54 months) and time 2 (Grade 4) is .07. The raw difference between the mean CBCL Attention Problems Scale T-score for children for time 1 (54 months) and time 2 (Grade 4) is .01.

Estimates of effect size were generated by SPSS using the partial η^2 value.

Examination of effect sizes and observed power indicate sufficient power to detect significant effects (power = .053, α = .05) and an effect size of .000. When considering effect size of differences between two groups, a commonly accepted practice is to regard a partial η^2 effect size value of .01 as representing small clinical differences, .09 represents moderate clinical differences, and .25 represents large clinical differences (Tabachnick & Fidell, 2007).

Hypothesis #4

Boys and girls studied separately will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behavior related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by, maternal ratings on the CBCL attention scale and CPT performance.

Statistical Analysis

To determine if the study's participating boys and girls fail to exhibit a statistically significant difference between normatively-derived levels of effortfully controlled behavior at 54 months and fourth grade when studied separately. Hypotheses #4 was tested with two one way, two level Multivariate Analyses of Variance (MANOVA). The

first of these analyses was conducted with the samples girls and the second with the samples boys. In each of these analyses “Time” served as the independent variable (the grouping variable) and measures of effortfully controlled behavior (CBCL attention scale T scores, CPT Omission Errors T scores and CPT Commission Errors T scores) as the dependent variable. Measures of effortfully controlled behavior were collected at 54 months and again when the participants were in fourth grade.

Assumptions

MANOVA rely upon five assumptions: multicollinearity, independence, linearity, normality, and homogeneity of variance-covariance. Separate tests of the assumptions of multicollinearity, independence, linearity, and normality for boys and girls were described above. The assumptions of homogeneity of variance-covariance matrices was examined for robustness using the Box’s M test separately for boys and girls. The Box’s M test is significant when the variance across dependent measures differs. The Box’s M test is also sensitive to violations of the assumption of multivariate normality (Tabachnick & Fidell, 2007). Results of the Box’s M test for both boys and girls indicate a violation of the assumption of homogeneity of variance-covariance. This violation suggests that the covariance matrices are too dissimilar to entirely rely upon use of the Wilks’ Lambda statistic (Stevens, 2002). It also indicates as reported above that the assumption of multivariate normality is violated. Both the Pillai's Trace and the Wilks' Lambda statistics will be reported. The Wilks' lambda will be reported because it is the most commonly reported (Tabachnick & Fidell, 2007) and the Pillai's Trace statistic is reported because it is the most robust to the violation of homogeneity of variance-covariance.

Girls.

Table 35 shows a one way, two level MANOVA of the study's girls. The intention of the MANOVA is to determine if the study's participating girls exhibit no difference between normatively-derived levels of effortfully controlled behavior at time 1 (54 months) and time 2 (Grade 4). In this way the stability over time of the construct of effortful control can be measured. The MANOVA compares the vector of population means for time 1 (54 months) and time 2 (Grade 4) on the measures of effortfully controlled behavior. Time is used as the grouping (independent) variable and the combined variance of the three dependant measures of effortfully controlled behavior (CBCL: Attention Scale T scores, CPT Omission Errors T scores and CPT Commission Errors T scores) serves as the dependent variable.

Table 35

Summary MANOVA Table Comparing Girls' Effortful Control Performance at 54 Months to Girls' Effortful Control Performance at Grade 4.

<u>Independent Variable:</u>	Effortful Control MANOVA				
	<i>df</i>	<i>F</i>	<i>Sig.</i>	<i>Effect size</i>	<i>Observed Power^a</i>
Time	1, 398	.604	.613	.002	.117

Note. MANOVA = multivariate analysis of variance

a: Computed using alpha = .05

Results of the MANOVA analysis of the study's girls using both the Wilk's criterion and the Pillai's Trace statistic, show no statistically significant difference between the

vector of population means for time 1 (54 months) and time 2 (Grade 4) on the measures of effortfully controlled behavior ($F(1, 398) = .604, p = .613$), with a Wilks' Lambda value of 0.998 and a Pillai's Trace value of .002. Examination of effect sizes and observed power indicate sufficient power to detect significant effects (power = .177, $\alpha = .05$) and an effect size of .002. Estimates of effect size were generated by SPSS using the partial η^2 value. When considering effect size of differences between two groups, a commonly accepted practice is to regard a partial η^2 effect size value of .01 as representing small clinical differences, .09 represents moderate clinical differences, and .25 represents large clinical differences (Tabachnick & Fidell, 2007).

Descriptive statistics demonstrating the summary distribution of mean, standard deviation, and range for each dependant variable measure of effortful control of only the girls is presented in Table 14. Raw scores and T scores are presented for CPT data. The raw difference between girls' mean CPT omission error T-scores for time 1 (54 months) and time 2 (Grade 4) is .12. Univariate F tests indicate no statistically significant difference between girls' mean CPT omission error T-scores for time 1 (54 months) and time 2 (Grade 4) ($F(1, 796) = .040, p = .842$). The raw difference between girls' mean CPT commission error T-scores for time 1 (54 months) and time 2 (Grade 4) is 0.03. Univariate F tests indicate no statistically significant difference between girls' mean CPT commission error T-scores for time 1 (54 months) and time 2 (Grade 4) ($F(1, 796) = 0.006, p = .939$). The raw difference between the mean CBCL Attention Problems Scale T-score for children for time 1 (54 months) and time 2 (Grade 4) is .53. Univariate F tests indicate no statistically significant difference between girls' mean CBCL Attention

Problems Scale T-score for time 1 (54 months) and time 2 (Grade 4) ($F(1, 796) = 1.785$, $p = .182$).

Boys.

Table 36 shows a one way, two level MANOVA of the study's boys. The intention of the MANOVA is to determine if the study's participating boys exhibit no difference between normatively-derived levels of effortfully controlled behavior at time 1 (54 months) and time 2 (Grade 4). In this way the stability over time of the construct of effortful control can be measured. The MANOVA compares the vector of population means for time 1 (54 months) and time 2 (Grade 4) on the measures of effortfully controlled behavior. Time is used as the grouping (independent) variable and the combined variance of the three dependant measures of effortfully controlled behavior (CBCL: Attention Scale T scores, CPT Omission Errors T scores and CPT Commission Errors T scores) serves as the dependent variable.

Table 36

Summary MANOVA Table Comparing Boys' Effortful Control Performance at 54 Months to Boys' Effortful Control Performance at Grade 4.

Effortful Control MANOVA					
<u>Independent Variable:</u>	<i>df</i>	<i>F</i>	<i>Sig.</i>	<i>Effect size</i>	<i>Observed Power^a</i>
Time	1, 375	.737	.530	.003	.208

Note. MANOVA = multivariate analysis of variance

a: Computed using alpha = .05

Results of the MANOVA analysis of the boys using both the Wilk's criterion and the Pillai's Trace statistic, show no statistically significant difference between the vector of population means for time 1 (54 months) and time 2 (Grade 4) on the measures of effortfully controlled behavior ($F(1, 375) = .737, p = .530$), with a Wilks' Lambda value of .997 and a Pillai's Trace value of .003. Estimates of effect size were generated by SPSS using the partial η^2 value. Examination of effect sizes and observed power indicate sufficient power to detect significant effects (power = .208, $\alpha = .05$) and an effect size of .003. When considering effect size of differences between two groups, a commonly accepted practice is to regard a partial η^2 effect size value of .01 as representing small clinical differences, .09 represents moderate clinical differences, and .25 represents large clinical differences (Tabachnick & Fidell, 2007).

Descriptive statistics demonstrating the summary distribution of mean, standard deviation, and range for each dependant variable measure of effortful control of only the boys is presented in Table 13. Raw scores and T scores are presented for CPT data. The raw difference between boys' mean CPT omission error T-scores for time 1 (54 months) and time 2 (Grade 4) is .06. Univariate F tests indicate no statistically significant difference between girls' mean CPT omission error T-scores for time 1 (54 months) and time 2 (Grade 4) ($F(1, 750) = .006, p = .938$). The raw difference between boys' mean CPT commission error T-scores for time 1 (54 months) and time 2 (Grade 4) is 0.12. Univariate F tests indicate no statistically significant difference between boys' mean CPT commission error T-scores for time 1 (54 months) and time 2 (Grade 4) ($F(1, 750) = .023, p = .880$). The raw difference between the mean CBCL Attention Problems Scale T-score for children for time 1 (54 months) and time 2 (Grade 4) is .57. Univariate F tests

indicate no statistically significant difference between girls' mean CBCL Attention Problems Scale T-score for time 1 (54 months) and time 2 (Grade 4) ($F(1, 750) = 2.127$, $p = .145$).

Research Question #2

The question, “Does security of attachment to a primary care provider at 36 months of age, affect subsequently developed effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation, as measured by, maternal ratings on the CBCL attention scale and CPT performance, at fourth grade, after controlling for the effects of social contextual adversity?” will be answered by testing two hypotheses. These hypotheses concern the manifest differences in effortfully controlled behavior between children assessed as enjoying a secure maternal attachment and children rated as insecurely attached to their mothers after controlling for cumulative social contextual risk.

Hypothesis #5

Children that are rated as insecurely attached at 36 months will exhibit more poorly developed effortful controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, than peers that are securely attached at 36 months after taking social contextual adversity into account.

Statistical Analysis

To examine if securely and insecurely attached children significantly differed in regard to effortfully controlled behavior after controlling for cumulative social contextual risk, a Multivariate Analyses of Covariance (MANCOVA) was conducted. Hypothesis #5 was tested with a one way, two level MANCOVA. The MANCOVA analyzed maternal

attachment security as the independent variable (two levels secure versus insecure). The cumulative social contextual risk index was treated as a covariate in these MANCOVA and the construct of EC was the dependant variable.

Rationale for Selection of Statistical Analysis

MANCOVA was selected for these analyses because of the necessity of controlling for the effects of cumulative social contextual risk (covariate) upon the dependant variable (EC). As discussed above, the effects of cumulative social contextual risk have been demonstrated to affect children's cognitive and behavioral developmental outcomes (Cicchetti, 2002; Rutter & Sroufe, 2000). Because the current study was interested in discovering the unique variance contributed by maternal attachment security (the independent variable) to the subsequent formation of EC (the dependent variable) it was necessary to identify and control for the variance contributed by cumulative social contextual risk (a supplementary continuous independent variable or covariate). By definition a covariate is a variable (or set of variables) that contributes variance to, or effects, the dependent variable. The difference between an independent variable (i.e., maternal attachment security) and a covariate (i.e., cumulative social contextual risk) is the effect of the covariate is not of interest to the research.

Assumptions

MANCOVA rely upon six assumptions: multicollinearity, independence, linearity, normality, homogeneity of variance-covariance, and homogeneity of regression. The assumptions of multicollinearity, independence, linearity, normality and homogeneity of variance-covariance were described above. The assumption of homogeneity of regression was tested by an examination of the interactions between the covariate and each

independent factor. Statistically significant interactions indicate an increased likelihood of Type I errors (finding significant difference when none exists by mistakenly rejecting a null hypothesis). Univariate and multivariate tests of the assumption of homogeneity of regression reveal statistically significant interactions between the covariate (cumulative social contextual risk index) and the independent variable (the fixed factor of maternal attachment security) indicating a violation of the assumption of homogeneity of regression. Because the main analysis failed to reject the null hypothesis the MANCOVA is determined to be robust to the violation of the assumption of homogeneity of regression. The violation of the assumption of homogeneity of variance-covariance described above suggests that the covariance matrices are too dissimilar to entirely rely upon use of the Wilks' Lambda statistic (Stevens, 2002). Both the Pillai's Trace and the Wilks' Lambda statistics will be reported. The Wilks' lambda will be reported because it is the most commonly reported (Tabachnick & Fidell, 2007) and the Pillai's Trace statistic is reported because it is the most robust to the violation of homogeneity of variance-covariance.

Table 37 shows a one way, two level MANCOVA of all study participants. The intention of the MANCOVA presented in table 37 is to determine if the study's subjects differ in regard to normatively-derived levels of effortfully controlled behavior at fourth grade based upon strange situation evaluation of maternal attachment security at 36 months after controlling for cumulative social contextual risk. The MANCOVA compares the vector of population means for securely versus insecurely attached subjects (the independent variable) on the combined variance of the three dependant measures of effortfully controlled behavior (CBCL: Attention Scale T scores, CPT Omission Errors T

scores and CPT Commission Errors T scores) which serve as the dependent variable. The cumulative social contextual risk index score is used as the covariate.

Table 37

Summary MANCOVA Table Comparing Securely and Insecurely Attached Participants' on Effortful Control Performance at Grade 4 after Controlling for Cumulative Social Contextual Stress.

Effect	Effortful Control				
	MANCOVA				
	<i>df</i>	<i>F</i>	<i>Sig.</i>	<i>Effect size</i>	<i>Observed Power^a</i>
<u>Independent Variable:</u>					
Attachment Security	2, 773	2.340	.072	.009	.589
<u>Covariate:</u>					
Weighted Cumulative Social Contextual Stress Index	2, 773	31.196	.000	.108	1.000

Note. MANCOVA = multivariate analysis of covariance

a: Computed using alpha = .05

Results of the MANCOVA analysis for both the Wilk's criterion and the Pillai's Trace statistic failed to show significant difference between the vector of population means for securely versus insecurely attached subjects on the combined variance of the three dependant measures of effortfully controlled behavior after controlling for cumulative social contextual risk ($F(2, 773) = 2.340, p = .072$) with a Wilks' Lambda value of .991 and a Pillai's Trace value of 0.009. Estimates of effect size of the fixed

factor, Attachment Security, were generated by SPSS using the partial η^2 value.

Examination of effect sizes and observed power indicate sufficient power to detect significant effects (power = .589, α = .05) and an effect size of .009 demonstrating no significant effect.

MANCOVA results in table 38 indicate the covariate, cumulative social contextual risk, contributes significant variance to the dependant measures of effortfully controlled behavior ($F(2, 773) = 31.196, p < .000$) with a Wilks' Lambda value of .892 and a Pillai's Trace value of 0.108. Estimates of effect size of the covariate were generated by SPSS using the partial η^2 value. Examination of effect size and observed power indicate sufficient power to detect significant effects (power = 1.000, α = .05) and an effect size of .108. A partial η^2 effect size value of .108 represents moderate clinical differences (Tabachnick & Fidell, 2007).

Descriptive statistics demonstrating the summary distribution of mean and standard deviation for each dependant variable measure of effortful control separated by attachment classification is presented in Table 38.

Table 38

Summary Distribution of Mean and Standard Deviation: Measures of Effortful Control at Fourth Grade Separated by Attachment Classification

Dependant Effortful Control Variables		n	Mean	Standard Deviation
CPT: Omission Errors T-Score - Grade 4				
	Secure	500	48.91	8.16
	Insecure	275	51.16	11.40
CPT: Commission Errors T-Score - Grade 4				
	Secure	500	49.03	6.94
	Insecure	275	50.37	10.15
CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4				
	Secure	500	53.04	5.61
	Insecure	275	54.32	6.55

The raw difference between mean CPT omission error T-scores by attachment classification (secure versus insecure) is 2.25. Univariate F tests indicate a statistically significant difference between mean CPT omission error T-scores by attachment classification (secure versus insecure) ($F(1, 774) = 4.06, p = .044$). The raw difference between mean CPT commission error T-scores by attachment classification (secure versus insecure) is 1.34. Univariate F tests indicate no statistically significant difference between mean CPT commission error T-scores by attachment classification (secure versus insecure) ($F(1, 774) = .871, p = .351$). The raw difference between mean CBCL Attention Problems Scale T-score by attachment classification (secure versus insecure) is

1.28. Univariate F tests indicate no statistically significant difference between mean CBCL Attention Problems Scale T-score by attachment classification (secure versus insecure) ($F(1, 774) = 3.262, p = .071$).

Hypothesis #6

When boys and girls are studied separately, children that are rated as insecurely attached at 36 months will exhibit more poorly developed effortful controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, than peers that are securely attached at 36 months after taking social contextual adversity into account.

Statistical Analysis

To examine if securely and insecurely attached boys and girls who are studied separately significantly differed in regard to effortfully controlled behavior after controlling for cumulative social contextual risk, a series of two Multivariate Analyses of Covariance (MANCOVA) were conducted. Hypothesis #6 was tested with two one way, two level MANCOVAs (one with boys and one with only girls). Each of these MANCOVAs analyzed maternal attachment security as the independent variable (two levels secure versus insecure). The cumulative social contextual risk index was treated as a covariate in these MANCOVA and the construct of EC was the dependant variable.

Rationale for Selection of Statistical Analysis

MANCOVA was selected for these analyses because of the necessity of controlling for the effects of cumulative social contextual risk (covariate) upon the dependant variable (EC). As discussed above, the effects of cumulative social contextual risk have been demonstrated to affect children's cognitive and behavioral developmental outcomes

(Cicchetti, 2002; Rutter & Sroufe, 2000). Because the current study was interested in discovering the unique variance contributed by maternal attachment security (the independent variable) to the subsequent formation of EC (the dependent variable) it was necessary to identify and control for the variance contributed by cumulative social contextual risk (a supplementary continuous independent variable or covariate). By definition a covariate is a variable (or set of variables) that contributes variance to, or effects, the dependent variable. The difference between an independent variable (i.e., maternal attachment security) and a covariate (i.e., cumulative social contextual risk) is the effect of the covariate is not of interest to the research.

Assumptions

MANCOVA rely upon six assumptions: multicollinearity, independence, linearity, normality, homogeneity of variance-covariance, and homogeneity of regression. The assumptions of multicollinearity, independence, linearity, normality and homogeneity of variance-covariance were tested for boys and girls separately and the results were described above. The assumption of homogeneity of regression was tested for boys and girls separately by an examination of the interactions between the covariate and each independent factor. Statistically significant interactions in both samples indicate an increased likelihood of Type I errors (finding significant difference when none exists by mistakenly rejecting a null hypothesis). Univariate and multivariate tests of the assumption of homogeneity of regression reveal statistically significant interactions between the covariate (cumulative social contextual risk index) and the independent variable (the fixed factor of maternal attachment security) indicating a violation of the assumption of homogeneity of regression. Because the main analysis failed to reject the

null hypothesis for both boys and girls these MANCOVAs are determined to be robust to the violation of the assumption of homogeneity of regression. The violation of the assumption of homogeneity of variance-covariance described above suggests that the covariance matrices are too dissimilar to entirely rely upon use of the Wilks' Lambda statistic alone (Stevens, 2002). Both the Pillai's Trace and the Wilks' Lambda statistics will be reported. The Wilks' lambda will be reported because it is the most commonly reported (Tabachnick & Fidell, 2007) and the Pillai's Trace statistic is reported because it is the most robust to the violation of homogeneity of variance-covariance.

Boys.

Table 38 shows a one way, two level MANCOVA of all boys. The intention of the MANCOVA presented in table 38 is to determine if the study's boys differ in regard to normatively-derived levels of effortfully controlled behavior at fourth grade based upon strange situation evaluation of maternal attachment security at 36 months after controlling for cumulative social contextual risk. The MANCOVA compares the vector of population means for securely versus insecurely attached boys (the independent variable) on the combined variance of the three dependant measures of effortfully controlled behavior (CBCL: Attention Scale T scores, CPT Omission Errors T scores and CPT Commission Errors T scores) which serve as the dependent variable. The cumulative social contextual risk index score is used as the covariate.

Table 39

Summary MANCOVA Table Comparing Securely and Insecurely Attached Boys on Effortful Control Performance at Grade 4 after Controlling for Cumulative Social Contextual Stress.

Effect	Effortful Control				
	MANCOVA				
	<i>df</i>	<i>F</i>	<i>Sig.</i>	<i>Effect size</i>	<i>Observed Power^a</i>
<u>Independent Variable:</u>					
Attachment Security	2, 374	1.462	.224	.012	.387
<u>Covariate:</u>					
Weighted Cumulative Social Contextual Stress Index	2, 374	15.071	.000	.109	1.000

Note. MANCOVA = multivariate analysis of covariance

a: Computed using alpha = .05

Results of the MANCOVA analysis using both the Wilk's criterion and the Pillai's Trace statistic, failed to show significant difference between the vector of population means for securely versus insecurely attached boys on the combined variance of the three dependant measures of effortfully controlled behavior after controlling for cumulative social contextual risk ($F(2, 374) = 1,462, p = .224$) with a Wilks' Lambda value of .988 and a Pillai's Trace value of 0.012. Estimates of effect size of the fixed factor, Attachment Security, were generated by SPSS using the partial η^2 value. Examination of

effect sizes and observed power indicate sufficient power to detect significant effects (power = .387, $\alpha = .05$) and an effect size of .012 demonstrating small significant effect.

MANCOVA results in table 39 indicate the covariate, cumulative social contextual risk, contributes significant variance to the dependant measures of effortfully controlled behavior ($F(2, 374) = 15.071, p < .000$) with a Wilks' Lambda value of .891 and a Pillai's Trace value of 0.109. Estimates of effect size of the covariate were generated by SPSS using the partial η^2 value. Examination of effect size and observed power indicate sufficient power to detect significant effects (power = 1.000, $\alpha = .05$) and an effect size of .109. A partial η^2 effect size value of .109 represents moderate clinical differences (Tabachnick & Fidell, 2007).

Descriptive statistics demonstrating the summary distribution of boys' mean and standard deviation for each dependant variable measure of effortful control separated by attachment classification is presented in Table 40.

Table 40

Summary Distribution of Boys' Mean and Standard Deviation: Measures of Effortful Control Separated by Attachment Classification

Dependant Effortful Control Variables		n	Mean	Standard Deviation
CPT: Omission Errors T-Score - Grade 4				
	Secure	259	49.42	9.09
	Insecure	117	53.10	12.45
CPT: Commission Errors T-Score - Grade 4				
	Secure	259	51.07	8.09
	Insecure	117	53.40	12.42
CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4				
	Secure	259	53.06	5.67
	Insecure	117	54.44	5.97

The raw difference between boys' mean CPT omission error T-scores by attachment classification (secure versus insecure) is 3.68. Univariate F tests indicate no statistically significant difference between boys' mean CPT omission error T-scores by attachment classification (secure versus insecure) ($F(1, 375) = 2.836, p = .093$). The raw difference between boys' mean CPT commission error T-scores by attachment classification (secure versus insecure) is 2.33. Univariate F tests indicate no statistically significant difference between boys' mean CPT commission error T-scores by attachment classification (secure versus insecure) ($F(1, 375) = .971, p = .339$). The raw difference between boys' mean CBCL Attention Problems Scale T-score by attachment classification (secure versus

insecure) is 1.38. Univariate F tests indicate no statistically significant difference between boys' mean CBCL Attention Problems Scale T-score by attachment classification (secure versus insecure) ($F(1, 375) = 1.639, p = .201$).

Girls.

Table 41 shows a one way, two level MANCOVA of all girls. The intention of the MANCOVA presented in table 41 is to determine if the study's girl subjects differ in regard to normatively-derived levels of effortfully controlled behavior at fourth grade based upon strange situation evaluation of maternal attachment security at 36 months after controlling for cumulative social contextual risk. The MANCOVA compares the vector of population means for securely versus insecurely attached subjects (the independent variable) on the combined variance of the three dependant measures of effortfully controlled behavior (CBCL: Attention Scale T scores, CPT Omission Errors T scores and CPT Commission Errors T scores) which serve as the dependent variable. The cumulative social contextual risk index score is used as the covariate.

Table 41

Summary MANCOVA Table Comparing Securely and Insecurely Attached Girls on Effortful Control Performance at Grade 4 after Controlling for Cumulative Social Contextual Stress.

Effect	Effortful Control				
	MANCOVA				
	<i>df</i>	<i>F</i>	<i>Sig.</i>	<i>Effect size</i>	<i>Observed Power^a</i>
<u>Independent Variable:</u>					
Attachment Security	2,397	1.653	.177	.012	.433
<u>Covariate:</u>					
Weighted Cumulative Social Contextual Stress Index	2,397	18.461	.000	.123	1.000

Note. MANCOVA = multivariate analysis of covariance

a: Computed using alpha = .05

Results of the MANCOVA analysis using both the Wilk's criterion and the Pillai's Trace statistic, failed to show significant difference between the vector of population means for securely versus insecurely attached girls on the combined variance of the three dependant measures of effortfully controlled behavior after controlling for cumulative social contextual risk ($F(2, 397) = 1.653, p = .177$) with a Wilks' Lambda value of .988 and a Pillai's Trace value of 0.012. Estimates of effect size of the fixed factor, Attachment Security, were generated by SPSS using the partial η^2 value. Examination of

effect sizes and observed power indicate sufficient power to detect significant effects (power = .433, $\alpha = .05$) and an effect size of .012 demonstrating a small clinical effect. MANCOVA results in table 41 indicate the covariate, cumulative social contextual risk, contributes significant variance to the dependant measures of effortfully controlled behavior ($F(2, 397) = 18.461, p < .000$) with a Wilks' Lambda value of .877 and a Pillai's Trace value of 0.123. Estimates of effect size of the covariate were generated by SPSS using the partial η^2 value. Examination of effect size and observed power indicate sufficient power to detect significant effects (power = 1.000, $\alpha = .05$) and an effect size of .123. A partial η^2 effect size value of .123 represents moderate clinical differences (Tabachnick & Fidell, 2007).

Descriptive statistics demonstrating the summary distribution of girls' mean and standard deviation for each dependant variable measure of effortful control separated by attachment classification is presented in Table 42.

Table 42

Summary Distribution of Girls' Mean and Standard Deviation: Measures of Effortful Control Separated by Attachment Classification

Dependant Effortful Control Variables		n	Mean	Standard Deviation
CPT: Omission Errors T-Score - Grade 4				
	Secure	241	48.36	7.00
	Insecure	158	49.73	10.36
CPT: Commission Errors T-Score - Grade 4				
	Secure	241	46.85	4.55
	Insecure	158	48.13	7.36
CBCL: Maternal Responses to Attention Problems Scale T-Score - Grade 4				
	Secure	241	53.01	5.56
	Insecure	158	54.23	6.96

The raw difference between girls' mean CPT omission error T-scores by attachment classification (secure versus insecure) is 1.37. Univariate F tests indicate no statistically significant difference between girls' mean CPT omission error T-scores by attachment classification (secure versus insecure) ($F(1, 398) = 1.556, p = .213$). The raw difference between girls' mean CPT commission error T-scores by attachment classification (secure versus insecure) is 1.28. Univariate F tests indicate no statistically significant difference between girls' mean CPT commission error T-scores by attachment classification (secure versus insecure) ($F(1, 398) = 2.54, p = .112$). The raw difference between girls' mean CBCL Attention Problems Scale T-score by attachment classification (secure versus

insecure) is 1.22. Univariate F tests indicate no statistically significant difference between girls' mean CBCL Attention Problems Scale T-score by attachment classification (secure versus insecure) ($F(1, 398) = 1.944, p = .164$).

CHAPTER V

DISCUSSION

Development of the self-regulatory elements of executive control is arguably one of the most critical and significant developmental achievements of early childhood (Bandura, 1977; Kopp, 1982; Luria, 1980; Olson, et al., 1990). Executive control and self-regulation are constructs that reside at the nexus of developmental, neuropsychological, and clinical investigations. Executive control and self-regulatory deficits each impact at least three major functional domains: (a) affective (NICHD Early Child Care Network, 2004), (b) cognitive (Luria, 1980; Olson et al., 1990), and (c) social (Denham et al., 2002; Thompson, 1994). Because emotional, cognitive, and social processes are developmentally interrelated and interdependent (Bell & Wolfe, 2004; Davis, et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000) neither the terms *Executive Control* nor *Self-Regulation* adequately represent the myriad emotional, social and cognitive implications and bidirectional impacts of dysfunction in these arenas. The term *Executive Control* connotes neuropsychological and cognitive functioning, whereas *Self-Regulation* suggests social and emotional developmental processes.

Effortful Control (EC) is a construct representing a hybridization of these separate but intertwined notions (Posner & Rothbart, 2000; Rothbart, 1989; Rothbart, & Ahadi, 1994; Rothbart & Bates, 1998; Rothbart et al., 1994; Rothbart et al., 2003). The construct describes the self regulatory aspects of the executive control system. Effortful Control is of special interest and use, because, despite the traditional practice of conceptualizing cognitive and emotional processes as independent of one another, the construct of EC

places emotional, cognitive, and behavioral self-regulatory capacities together (Davis et al., 2002; Eisenberg & Spinrad, 2004; Posner & Rothbart, 2000). Effortful Control refers to emotional, social, and cognitive regulatory function, with the understanding that the separation of emotional, social, and cognitive developmental processes is an artifact of the fractionization of psychology, rather than an organically based distinction. Though EC is a construct developed by Rothbart and colleagues as part of their work on temperament (Posner & Rothbart, 2000; Rothbart, 1989; Rothbart, & Ahadi, 1994; Rothbart & Bates, 1998; Rothbart et al., 1994; Rothbart et al., 2003), the utility of conceptualizing emotional, social, and cognitive control processes together as a unitary notion that is salient to developmental outcomes beyond early childhood is unmistakable. Overwhelmingly, the evidence supports the interdependence between emotional, social, and cognitive functions (Bell & Wolfe, 2004; Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000). A consequence of serious dysfunction in any one of these domains (emotional, social, or cognitive) will most often result in decrements to self-regulatory and executive functioning (Cicchetti, 2002). For this reason the construct of EC is here extended upward to pertain to and describe emotional, social, and cognitive control processes through late childhood. This upward extension of Rothbart's and Bates' (1998) temperament construct may aid in the quest to develop a better understanding of psychopathology and the developmental pathogeneses of numerous disorders related to attention, executive function and conduct (Nigg et al., 2004).

Dysregulated and undercontrolled children manifest difficulties controlling the intensity, valence, and duration of their affective experience (Powell & Kytja, 2004).

Linehan (1993) identified three distinctive characteristics of emotional dysregulation including: a lower than typical affective arousal threshold, dramatic and intense emotional reactions, and a slower than typical return to affective baseline. These children often demonstrate more frequent and intense negative emotional states than do their better regulated peers. Cognitively, children experiencing poorly developed executive control show greater difficulty with “goal-oriented behavior in response to environmental contingencies” (Romine & Reynolds, 2005, p. 191) as well as problems with attentional focusing, planning, mental flexibility, (Eisenberg & Spinrad, 2004; Posner, 1995; Posner & Rothbart, 1998; Rothbart & Bates, 1998; Rothbart et al., 1994) memory, “internalized” speech, problem-solving (Luria, 1961; Mischel & Patterson, 1979; Wertsch, 1984 as cited by Olson et al., 1990), and, most critically, inhibitory/activational control (Stuss & Alexander, 2000) and response inhibition/impulse control problems (Barkley, 1997a). These emotional and cognitive difficulties are thought to contribute to poorly regulated children’s social and academic struggles (Anderson et al., 2001).

The Purpose

The purpose of the study is to provide an improved understanding of the association between children’s early experiences and ensuing developmental outcomes. This goal was accomplished by exploring the connection between the security of young children’s maternal attachment relationships and the subsequent formation of the child’s executive control system. Specifically, the aim of the study was to explore if securely versus insecurely attached children differ in regard to their subsequent formation of Effortful Control processes that relate to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity. To that end, a select dataset

from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care (SECC) database was analyzed to explore two questions. The first question concerned the stability of the construct of EC over time. The second research question addressed the central theme of the study; do children of varying levels of maternal attachment security significantly differ in regard to their subsequent formation of EC processes related to attentional control, impulsivity and emotional regulation, after controlling for the effects of social contextual adversity?

A number of hypotheses related to each of these questions were proposed and tested. A brief summary and discussion articulating the results of the various analyses is here presented in non-statistical terms.

Summary

Question One Summary

The statistical analyses related to the first research question addressed the question: “Does effortfully controlled behavior related to attentional control, impulsivity and emotional regulation as measured by maternal ratings on the CBCL attention scale and CPT performance remain stable from 54 months of age to fourth grade?” Or more simply: “Is the construct of effortful control stable over time?” Four hypotheses related to this question were proposed and tested.

The first two hypotheses related to this question concern the ability of observational and performance data collected in phase II during the 54 month laboratory visit to predict the outcome of observational and performance data collected in phase III during the fourth grade laboratory visit.

Hypothesis #1

Effortfully controlled behaviors related to attentional control, impulsivity and emotional regulation as measured by maternal ratings on the CBCL attention scale and CPT performance, measured at 54 months of age will predict similar effortfully controlled behaviors measured at fourth grade.

Hypothesis #2

Effortfully controlled behaviors related to attentional control, impulsivity and emotional regulation as measured by maternal ratings on the CBCL attention scale and CPT performance, at 54 months of age will predict similar effortfully controlled behaviors measured at fourth grade for boys and girls studied separately.

Hypothesis #1 and #2 Results

Results of stepwise multiple regression analysis of all subjects (hypothesis #1) and boys and girls studied separately (hypothesis #2) indicate that observational and performance data collected in phase II during the 54 month laboratory visit is a statistically significant predictor of observational and performance data collected in phase III during the fourth grade laboratory visit. Though observational and performance data collected during the 54 month laboratory visit is statistically significant in predicting observational and performance data collected during the fourth grade laboratory visit, the specific amount of variance contributed to predicting each measure was variable. The specific amount of variance contributing to the prediction of the observational and performance data collected during the fourth grade laboratory visit ranged from 27.4% to 4.0% depending upon the measure.

In general, results of stepwise multiple regression analysis indicated that each unique measurement scale best predicted the fourth grade version of itself (e.g., the 54 month laboratory visit CPT Omission error T-score contributed the greatest amount of variance to the fourth grade laboratory visit CPT Omission error T-score). Two noteworthy exceptions to this general trend were identified. 1) The boys' only analysis indicated the 54 month laboratory visit CBCL attention scale best predicted the fourth grade laboratory visit CPT Commission error T-score and 2) The girls' only analysis indicated the 54 month laboratory visit CPT Commission error T-score best predicted the fourth grade laboratory visit CPT Omission error T-score.

The next two hypotheses addressed the stability of the construct of effortful control by testing the difference between normatively-derived levels of effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by maternal ratings on the CBCL attention scale and CPT performance.

Hypothesis #3

The study's participating children will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by maternal ratings on the CBCL attention scale and CPT performance.

Hypothesis #4

Boys and girls studied separately will exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behavior related to

attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by, maternal ratings on the CBCL attention scale and CPT performance.

Hypothesis # 3 and # 4 Results

Normatively-derived levels of effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade were compared by a series of MANOVA analysis. As hypothesized results of the MANOVA analysis indicate the study's participating children exhibit no statistically significant difference between normatively-derived levels of effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at 54 months of age and fourth grade as measured by maternal ratings on the CBCL attention scale and CPT performance. Additionally, the same hypothesized result of the MANOVA analysis was true for boys and girls studied separately.

The results of the analyses testing hypotheses one (1) through four (4) suggest that some measures are more predictive of future performance and stable over time than others, but in general, the selected measures represent a construct (effortful control) that is predictive of future performance and *is* stable over time. Establishing the construct stability of effortful control is important because research question two concerns a longitudinal exploration of factors that may contribute to disruption of effortful control functioning. Such an inquiry is spurious if the very construct of EC itself is not established as stable over time. The implication of the established stability of the EC construct is that an exploration of the question "Does security of attachment to a primary care provider at 36 months of age, affect subsequently developed effortfully controlled

behaviors related to attentional control, impulsivity, and emotional regulation, as measured by maternal ratings on the CBCL attention scale and CPT performance, at fourth grade, after controlling for the effects of social contextual adversity?” is possible.

Question Two Summary

As discussed above the second research question addresses the central theme of the study; “Does security of attachment to a primary care provider at 36 months of age, affect subsequently developed effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation, as measured by maternal ratings on the CBCL attention scale and CPT performance, at fourth grade, after controlling for the effects of social contextual adversity?”

This question was addressed by testing two hypotheses. Both of these hypotheses concern the manifest differences in effortfully controlled behavior between children assessed as enjoying a secure maternal attachment and children rated as insecurely attached to their mothers after controlling for cumulative social contextual risk. The first set of analyses measured all subjects together, and the second set of analyses measured boys and girls separately. The effects of social contextual adversity were treated as a covariate (for a detailed discussion of the statistical treatment of social contextual adversity please refer to page 135-140 of Chapter 4). As discussed above, the effects of cumulative social contextual risk have been demonstrated to affect children’s cognitive and behavioral developmental outcomes (Beiderman et, al., 1995; Cicchetti, 2002; Olson et al., 2002; Rutter & Sroufe, 2000). Because the current study was interested in discovering the unique variance contributed by maternal attachment security (the independent variable) to the subsequent formation of EC (the dependent variable) it was

necessary to identify and control for the variance contributed by cumulative social contextual risk (a supplementary continuous independent variable or covariate). By definition a covariate is a variable (or set of variables) that contributes variance to, or effects, the dependent variable. The difference between an independent variable (i.e., maternal attachment security) and a covariate (i.e., cumulative social contextual risk) is that the effect of the covariate is not of interest to the research.

Hypothesis #5

Children rated as insecurely attached at 36 months will exhibit more poorly developed effortful controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, than peers that are securely attached at 36 months after taking social contextual adversity into account.

Hypothesis #6

When boys and girls are studied separately, children rated as insecurely attached at 36 months will exhibit more poorly developed effortful controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, than peers that are securely attached at 36 months after taking social contextual adversity into account.

Hypothesis #5 and #6 Results

Results of both the first set of analyses related to question two (all subjects together) and the second set of analyses related to question two (boys and girls separately) indicated that no significant differences in effortfully controlled behavior exist between securely and insecurely attached children, after controlling for cumulative social contextual risk. It is of interest to note that despite the fact that no statistically significant differences in effortfully controlled behavior exist between securely and insecurely

attached children the mean scores of every measure of EC behavior are consistently higher for the insecurely attached children. An additional point of interest is that both the first set of analyses (all subjects together) and the second set of analyses (boys and girls separately) indicated that the covariate, the Weighted Cumulative Social Contextual Stress Index was found to contribute significant variance to the dependent measures of effortfully controlled behavior.

Conclusions

Question One Conclusions

Question one sought to explore Murray & Kochanska's (2002) assertion that "effortful control (EC) is a ... construct with longitudinally stable factors" (p.503). Each of the four hypotheses related to question one contends that EC is a longitudinally stable construct. Evidence supporting the stability of EC is of special importance in regard to this study because research question two concerns a longitudinal exploration of environmental conditions in early childhood (e.g., maternal attachment security) which may contribute to disruption of subsequent effortful control function. An inquiry exploring social environmental conditions which may influence the expected trajectory of EC function is of little utility if the very stability of the construct in question (Effortful Control) is not first established as longitudinally stable over the time span in question.

This study's results offer evidence supporting Murray & Kochanska's (2002) work measuring children's EC function longitudinally from early childhood through early school age (approximately age 5 ½ years) to evidence the longitudinal stability of the construct of effortful control. In fact, results of this study's analyses extend the longitudinal stability of the construct of effortful control through children's fourth grade

year. One important implication of the established stability of the EC construct is that an exploration of possible factors which may disrupt EC function is possible. Examination of possible adverse social contextual conditions which may disrupt EC function is now feasible because evidence exists indicating that under typical (non-adverse) circumstances the construct of effortful control is longitudinally stable. This means that early measures of EC function are good predictors of later EC function. It follows then that an exploration of the relationship between adverse social contextual conditions and the subsequent formation of EC function is logical.

Question Two Conclusions

The intent of question two was to explore whether a real and measurable association exists between early attachment relationships, and the eventual formation of EC processes of the executive control system. Specifically, question two asks: “Does security of attachment to a primary care provider at 36 months of age, affect subsequently developed effortfully controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, after controlling for the effects of social contextual adversity?”

A vast body of literature support for the notion that disruption to the primary attachment relationship can have life-long consequences (Allen et al.,1996; Beretheron, 1992; Bowlby, 1988; Granot, & Mayseless, 2001; Liberman et al.,1999; Rice et al.,1997; Sund & Wichstrøm, 2002). These life-long consequences include: problems with affective and behavioral regulation (Clarke et. al, 2002), social competence, psychological adjustment, and cognitive functioning difficulties (Allen et al.,1996; Beretheron, 1992; Bowlby, 1988; Granot, & Mayseless, 2001; Liberman et al.,1999;

Rice et al., 1997; Sund & Wichstrøm, 2002). Disrupted early attachment relationships are also associated with deleterious emotional, behavioral, and cognitive consequences, such as increased rates of internalizing and externalizing disorders (Kopp, 1989; Fabes et al., 1999; Gross & John, 2003), underdeveloped social competence (Denham et al., 2002; Thompson, 1994), and increased rates of psychopathology such as Oppositional Defiant Disorder, Conduct Disorder, (Denham et al., 2002; Thompson, 1994) anxiety, depression (Gerhardt, 2004), and ADHD (Barkley, 1997).

A well reasoned and thoroughly documented two pronged argument was advanced in Chapter Two supporting the idea that disrupted early attachment relationships may undermine and interrupt the formation of emotional and neural architecture critical to development (Clarke et. al, 2002; Schore, 2000). It is suggested that an insecure attachment to a primary care provider can impact developing neuropsychological (Essex et al., 2002; Gerhardt, 2004; Lyons et al., 2000; Schore, 2001a; Schore, 2001b; Schore, 2001c) and psychosocial systems (Ainsworth, 1989; Beretheron, 1992; Bowlby, 1988; Brazelton & Greenspan, 2000; Karen, 1998) in such a way that may *cause* significant disruption of EC processes of the executive control system. Damage to the neural substrates undergirding EC processes of the executive control system leads to the diminution of behavioral, cognitive and emotional control capacities (Bell & Wolfe, 2004; Davis et al., 2002; Iverson & Dunnett, 1990; Lyons et al., 2000; Posner & Rothbart, 2000) contributing to the pathogenesis of many emotional, behavioral, and cognitive disorders.

The notion of a connection between attachment security and EC is also consistent with the central tenets of Bowlby's (1969) original conception of attachment. He

theorizes that social, emotional and environmental events and conditions inform developing psychological, biological and neural systems (Bowlby, 1969; Schore, 2000). Similarly, Piaget believed that an integration of the developmental sciences drawing together findings from psychology, psychiatry and neuroscience would better explain cognitive function (Cicchetti, 2002; Piaget, 1975).

Based upon the above cited research, it was hypothesized “Children who are insecurely attached at 36 months will exhibit more poorly developed effortful controlled behaviors related to attentional control, impulsivity, and emotional regulation at fourth grade, than peers who are securely attached at 36 months after taking social contextual adversity into account.” This hypothesis was tested by examining all subjects together (Hypothesis 5) and by examining boys and girls separately (Hypothesis 6).

Despite a well reasoned and researched rationale indicating that statistically significant differences are expected between the manifest ability of securely and insecurely attached children to exercise EC capacities related to attentional control, impulsivity, and emotional regulation after controlling for the effects of social contextual adversity, this study failed to support the hypothesized relationship. No statistically significant differences were found between the manifest ability of securely and insecurely attached children to exercise EC capacities related to attentional control, impulsivity and emotional regulation after controlling for the effects of social contextual adversity.

There are two reasonable explanations for failing to find statistical significance. The first of these explanations involves the time span between 36 months (when attachment was assessed) and fourth grade (when effortful control was assessed). It is possible that the adverse effects of a poor maternal attachment relationship may be “washed out” by

any number of intervening, unknown and unknowable variables. Six years is a long time in young children's development.

The second reasonable explanation for failing to find statistical significance involves the method of sorting children for comparison. In this study children rated as secure were compared to children rated as insecure. In many cases the distance was small between those children rated as *secure* who demonstrated a relatively low quality attachment bond, and those children rated as insecure who demonstrated a relatively high quality bond. This study gave no attention to severity of disrupted attachment. This is true because the study sought to discover if a statistically significant difference exists between children rated as secure and insecure. Statistical significance may exist if the independent variable attachment security had been better dichotomized. For example, if rather than dividing children by secure versus insecure attachment they were sorted so that only the children demonstrating the strongest of maternal bonds were compared to children manifesting signs of the most disrupted of attachment relationships.

Conversely, the covariate Cumulative Weighted Social Contextual Risk Index Score was found to contribute statistically significant variance to the dependant measures of effortfully controlled behavior. Put simply, children rated as securely versus insecurely attached did not demonstrate statistically significant differences in their ability to exercise EC capacities, but social contextual risk was found to be a statistically significant indicator of decrements to children's subsequent EC capacities.

Though these findings are not consistent with the research hypotheses related to question two or the research base compiled to support the advancement of those hypotheses, the findings are consistent with research that indicates the adverse impacts of

disruption to the mother-child attachment relationship more profoundly affect the developmental outcomes of children living with high levels of social contextual stress than lower-risk middle class children (Erickson, Sroufe, & Egeland 1985; Munson, McMahon, & Spieker, 2001; Renken, Egeland, Marvinney, Sroufe, & Mangelsdorf, 1989; Shaw & Vondra, 1995). The findings of question two are consistent with several studies that also failed to identify negative behavioral outcomes related to an insecure attachment classification in low-risk middle class children (Bates, Maslin, & Frankel, 1985; Belsky, Hsieh, & Crnic, 1998; Fagot & Kavanaugh, 1990). Additionally, this study's findings related to social contextual stress are consistent with the preponderance of evidence supporting the notion of a strong positive relationship between social contextual stress (Belsky & Pasco-Fearon, 2002; Biederman et al., 1995; NICHD Early Child Care Research Network, 2003; Rutter & Sroufe, 2000) and the functions described by the construct of EC.

Limitations

The primary limitation of this study concerns the measurement instruments. Because the focus of the research involved the longitudinal effects of maternal attachment, a preexisting longitudinal data set was selected for analysis. Although the measurement instruments available were adequate to assess if differences exist between securely and insecurely attached children, it must be stated that a comprehensive and well researched battery designed to measure effortful control function exists but was not available for this investigation. Kochanska & Murray's (N. D.) effortful control behavioral battery has been researched, and is well validated for measuring children's effortful control function.

A second limitation of this investigation relates to the sample. Although attrition rates were relatively low, it is likely that those participant families with the fewest resources were most likely drop from the study completely or fail to appear for all the required laboratory visits. In this way the possibility exists that the sample tended to exclude families facing the greatest social and environmental challenges.

Recommendations for Future Research

Based upon this study's finding that no statistically significant differences were found to exist between the manifest ability of securely and insecurely attached children to exercise EC capacities, a future research study should be conducted to reexamine the same question, but rather than group children by secure versus insecure attachment, severity of attachment disruption should be studied. The attachment variable should be dichotomized using the MacArthur coding system's global 9-point security rating, in which 1 = Very insecure, 3 = Insecure, 5 = Probably secure, 7 = Secure, and 9 = Very secure. (NICHD, 1999 p. 189) so that children rated 1 through 3 could be compared to children rated 7 through 9. By dichotomizing the attachment variable in this way a better estimation of the effect of attachment disruption can be ascertained.

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Appendix A

MY FEELINGS

The 20 statements below describe how people sometimes feel about themselves. Please answer all questions. THERE ARE NO RIGHT OR WRONG ANSWERS. Give your honest opinions and feelings. Please fill in the box that indicates how often you have felt this way during the past week.

- 1 - Rarely or none of the time (less than once a week)
- 2 - Some or a little of the time (1-2 days a week)
- 3 - Occasionally or a moderate amount of time (3-4 days a week)
- 4 - Most or all of the time (5-7 days a week)

1.	I was bothered by things that usually don't bother me.	1	2	3	4
2.	I felt that everything I did was an effort.	1	2	3	4
3.	I felt I was just as good as other people.	1	2	3	4
4.	I had trouble keeping my mind on what I was doing.	1	2	3	4
5.	I felt sad.	1	2	3	4
6.	I felt fearful.	1	2	3	4
7.	I felt lonely.	1	2	3	4
8.	I had crying spells.	1	2	3	4
9.	I talked less than usual.	1	2	3	4
10.	My sleep was restless.	1	2	3	4
11.	I enjoyed life.	1	2	3	4
12.	I felt that I could not shake off the blues even with the help of my family/friends.	1	2	3	4
13.	I thought my life had been a failure.	1	2	3	4
14.	I was happy.	1	2	3	4
15.	I could not get "going".	1	2	3	4
16.	I felt hopeful about the future.	1	2	3	4
17.	People were unfriendly to me.	1	2	3	4
18.	I did not feel like eating; my appetite was poor.	1	2	3	4
19.	I felt depressed.	1	2	3	4
20.	I felt that people dislike me.	1	2	3	4

ID NUMBER

REL

0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9

Appendix B

RELATIONSHIPS WITH OTHER PEOPLE

These questions ask about your relationships with the people who are important in your life. This might include your spouse or partner, your children, family, friends, or other important people in your life. For each question, please fill in the one answer that comes closest to how your relationships have been going in the past month.

ID NUMBER REL

0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9

1- None of the time
 2- A little of the time
 3- Some of the time
 4- A good bit of the time
 5- Most of the time
 6- All of the time

During the past month, how much of the time have you felt:

- | | | | | | | | |
|----|---|---|---|---|---|---|---|
| 1. | The people I care about make me feel that they care about me. | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. | The people important to me accept me as I am. | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. | I enjoy the time I spend with the people who are important to me. | 1 | 2 | 3 | 4 | 5 | 6 |

During the past month, how much of the time have you felt:

- | | | | | | | | |
|----|--|---|---|---|---|---|---|
| 4. | The people I care about seem interested in how I'm doing. | 1 | 2 | 3 | 4 | 5 | 6 |
| 5. | The people I care about come through for me when I need them. | 1 | 2 | 3 | 4 | 5 | 6 |
| 6. | When something is on my mind, just talking with the people I know can make me feel better. | 1 | 2 | 3 | 4 | 5 | 6 |

During the past month, how much of the time have you felt:

- | | | | | | | | |
|----|--|---|---|---|---|---|---|
| 7. | The people who are important to me encourage me when I feel discouraged or down. | 1 | 2 | 3 | 4 | 5 | 6 |
| 8. | I enjoy talking about everyday kinds of things with the people I care about. | 1 | 2 | 3 | 4 | 5 | 6 |
| 9. | The people I know are good sources of useful information when I need it. | 1 | 2 | 3 | 4 | 5 | 6 |

During the past month, how much of the time have you felt:

- | | | | | | | | |
|-----|---|---|---|---|---|---|---|
| 10. | The people I care about help me out. | 1 | 2 | 3 | 4 | 5 | 6 |
| 11. | When I need someone to help me out, I can usually find someone. | 1 | 2 | 3 | 4 | 5 | 6 |